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(54) **SUBSTITUTED TRIAZOLES AS HERBICIDES**

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C07D 249/06	(2006.01)
A01N 43/647	(2006.01)
C07D 401/06	(2006.01)
C07D 403/06	(2006.01)

(52) **U.S. Cl.**

CPC ***C07D 249/06*** (2013.01); ***A01N 43/647*** (2013.01); ***C07D 401/06*** (2013.01); ***C07D 403/06*** (2013.01)

(58) **Field of Classification Search**

CPC C07D 249/04

See application file for complete search history.

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(57) **ABSTRACT**

Disclosed are compounds of Formula 1, including all stereoisomers, N-oxides, and salts thereof,

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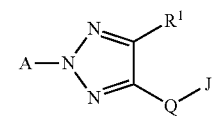

wherein A, R^1, Q and J are as defined in the disclosure. Also disclosed are compositions containing the compounds of Formula 1 and methods for controlling undesired vegetation comprising contacting the undesired vegetation or its environment with an effective amount of a compound or a composition of the invention.

12 Claims, No Drawings

SUBSTITUTED TRIAZOLES AS HERBICIDES

FIELD OF THE INVENTION

This invention relates to certain triazoles, their N-oxides, salts and compositions, and methods of their use for controlling undesirable vegetation.

BACKGROUND OF THE INVENTION

The control of undesired vegetation is extremely important in achieving high crop efficiency. Achievement of selective control of the growth of weeds especially in such useful crops as rice, soybean, sugar beet, maize, potato, wheat, barley, tomato and plantation crops, among others, is very desirable. Unchecked weed growth in such useful crops can cause significant reduction in productivity and thereby result in increased costs to the consumer. The control of undesired vegetation in noncrop areas is also important. Many products are commercially available for these purposes, but the need continues for new compounds that are more effective, less costly, less toxic, environmentally safe or have different sites of action.

SUMMARY OF THE INVENTION

This invention is directed to compounds of Formula 1 (including all stereoisomers), including N-oxides and salts thereof, agricultural compositions containing them and their use as herbicides:

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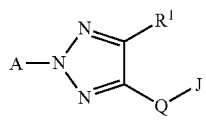
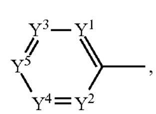


wherein

R^1 is halogen, cyano, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy, C_2-C_6 alkylcarbonyloxy, C_1-C_4 hydroxyalkyl, $SO_n(R^{12})$, C_2-C_4 alkylthioalkyl, C_2-C_4 alkylsulfonylalkyl, C_1-C_4 alkylamino C_2-C_4 dialkylamino, C_3-C_6 cycloalkyl or hydroxy;

A is a radical selected from the group consisting of

A-1



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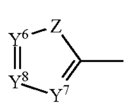 and

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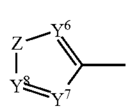


each Y^1, Y^2, Y^3, Y^4 and Y^5 is independently N or CR^2, provided no more than 3 of Y^1, Y^2, Y^3, Y^4 and Y^5 are N;

each Y^6, Y^7 and Y^8 is independently N or CR^3, provided no more than 2 of Y^6, Y^7 and Y^8 are N;

Z is O or S;

Q is $C(R^4)(R^5)$, O, S or NR^6;

J is phenyl substituted with 1 R^7 and optionally substituted with up to 2 R^8; or

J is a 6-membered aromatic heterocyclic ring substituted with 1 R^7 and optionally substituted with up to 2 R^8 on carbon ring members; or

J is a 5-membered aromatic heterocyclic ring substituted with 1 R^9 on carbon ring members and R^{11} on nitrogen ring members; and optionally substituted with 1 R^{10} on carbon ring members;

each R^2 is independently H, halogen, cyano, nitro, SF_5, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy or $S(O)_nR^{12}$;

each R^3 is independently H, halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$;

R^4 is H, F, Cl, Br, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl or CO_2R^{13};

R^5 is H, F, C_1-C_4 alkyl, OH or OR^{13}; or

R^4 and R^5 are taken together with the carbon to which they are attached to form C(═O), C(═NOR^{13}) or C(═N—$N(R^{14})(R^{15})$);

R^6 is H, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^7 is halogen, cyano, SF_5, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$;

each R^8 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$; or

R^7 and R^8 are taken together with two adjacent carbon atoms to form a 5-membered ring containing ring members selected from carbon atoms and up to two O atoms and up to two S atoms, and optionally substituted on carbon atom ring members with up to five halogen atoms;

R^9 is halogen, cyano, SF_5, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$;

R^{10} is halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$;

R^{11} is C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^{12} is independently C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^{13} is independently H or C_1-C_4 alkyl;

R^{14} is C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^{15} is C_1-C_4 alkyl or C_1-C_4 haloalkyl; and

each n is independently 0, 1 or 2;

provided

i) when R^1 is CH_3; A is A-1; Y^1, Y^2, Y^3 and Y^4 are each CH; and Y^5 is CCF_3 then J is other than 3-chloro-1H-1,2,4-thiadiazol-5-yl, 4-fluoro-2-pyridinyl, 4-chlorophenyl or 2,4-dichlorophenyl; and

ii) when R^1 is CH_3; A is A-1; Y^1, Y^2, Y^3 and Y^4 are each CH; and Y^5 is CF then J is other than 4-fluoro-3-methylphenyl.

More particularly, this invention pertains to a compound of Formula 1 (including all stereoisomers), an N-oxide or a salt thereof. This invention also relates to a herbicidal composition comprising a compound of the invention (i.e. in a herbicidally effective amount) and at least one component selected from the group consisting of surfactants, solid diluents and liquid diluents. This invention further relates to a method for controlling the growth of undesired vegetation comprising contacting the vegetation or its environment with a herbicidally effective amount of a compound of the invention (e.g., as a composition described herein).

This invention also includes a herbicidal mixture comprising (a) a compound selected from Formula 1, N-oxides, and salts thereof, and (b) at least one additional active ingredient selected from (b1) through (b16); and salts of compounds of (b1) through (b16).

DETAILS OF THE INVENTION

As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having," "contains", "containing," "characterized by" or any other variation thereof, are intended to cover a non-exclusive inclusion, subject to any limitation explicitly indicated. For example, a composition, mixture, process, method, that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such composition, mixture, process or method.

The transitional phrase "consisting of" excludes any element, step, or ingredient not specified. If in the claim, such would close the claim to the inclusion of materials other than those recited except for impurities ordinarily associated therewith. When the phrase "consisting of" appears in a clause of the body of a claim, rather than immediately following the preamble, it limits only the element set forth in that clause; other elements are not excluded from the claim as a whole.

The transitional phrase "consisting essentially of" is used to define a composition or method that includes materials, steps, features, components, or elements, in addition to those literally disclosed, provided that these additional materials, steps, features, components, or elements do not materially affect the basic and novel characteristic(s) of the claimed invention. The term "consisting essentially of" occupies a middle ground between "comprising" and "consisting of".

Where applicants have defined an invention or a portion thereof with an open-ended term such as "comprising," it should be readily understood that (unless otherwise stated) the description should be interpreted to also describe such an invention using the terms "consisting essentially of" or "consisting of."

Further, unless expressly stated to the contrary, "or" refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Also, the indefinite articles "a" and "an" preceding an element or component of the invention are intended to be nonrestrictive regarding the number of instances (i.e. occurrences) of the element or component. Therefore "a" or "an" should be read to include one or at least one, and the singular word form of the element or component also includes the plural unless the number is obviously meant to be singular.

As referred to herein, the term "seedling", used either alone or in a combination of words means a young plant developing from the embryo of a seed. As referred to herein, the term "broadleaf" used either alone or in words such as "broadleaf weed" means dicot or dicotyledon, a term used to describe a group of angiosperms characterized by embryos having two cotyledons. As used herein, the term "alkylating reagent" refers to a chemical compound in which a carbon-containing radical is bound through a carbon atom to a leaving group such as halide or sulfonate, which is displaceable by bonding of a nucleophile to said carbon atom. Unless otherwise indicated, the term "alkylating" does not limit the carbon-containing radical to alkyl; the carbon-containing radicals in alkylating agents include the variety of carbon-bound substituent radicals specified for R^1.

In the above recitations, the term "alkyl", used either alone or in compound words such as "alkylthio" or "haloalkyl" includes straight-chain or branched alkyl, such as, methyl, ethyl, n-propyl, i-propyl, or the different butyl, pentyl or hexyl isomers. The term "cycloalkyl" includes, for example, cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl. "Alkenyl" includes straight-chain or branched alkenes such as ethenyl, 1-propenyl, 2-propenyl, and the different butenyl isomers. "Alkenyl" also includes polyenes such as 1,2-propadienyl 1,3-butadienyl. "Alkynyl" includes straight-chain or branched alkynes such as ethynyl, 1-propynyl, 2-propynyl and the different butynyl and pentynyl isomers. "Alkynyl" can also include moieties comprised of multiple triple bonds such as 1,3-butadiynyl. "Alkoxy" includes, for example, methoxy, ethoxy, n-propyloxy, isopropyloxy and the different butoxy, pentoxy and hexyloxy isomers. "Alkoxyalkyl" denotes alkoxy substitution on alkyl. Examples of "alkoxyalkyl" include CH_3OCH_2, $CH_3OCH_2CH_2$, $CH_3CH_2OCH_2$ and $CH_3CH_2OCH_2CH_2$. "Alkenyloxy" includes straight-chain or branched alkenyloxy moieties. Examples of "alkenyloxy" include $H_2C{=}CHCH_2O$, $(CH_3)CH{=}CHCH_2O$ and $CH_2{=}CHCH_2CH_2O$. "Alkynyloxy" includes straight-chain or branched alkynyloxy moieties. Examples of "alkynyloxy" include $HC{\equiv}CCH_2O$ and $CH_3C{\equiv}CCH_2O$. "Alkylcarbonyloxy" includes straight-chain or branched alkylcarbonyloxy moieties. Examples of "alkylcarbonyloxy" include $CH_3C({=}O)O$, $(CH_3)_2CH_2C({=}O)O$ and $CH_3CH_2CH_2CH_2C({=}O)O$. "Alkylthio" includes branched or straight-chain alkylthio moieties such as methylthio, ethylthio and the different propylthio, butylthio isomers. "Alkylthioalkyl" denotes alkylthio substitution on alkyl. Examples of "alkylthioalkyl" include CH_3SCH_2, $CH_3SCH_2CH_2$, $CH_3CH_2SCH_2$ and $CH_3CH_2SCH_2CH_2$. Examples of "alkylsulfonyl" include $CH_3S(O)_2$—, $CH_3CH_2S(O)_2$— and $CH_3CH_2CH_2S(O)_2$—, and the different butylsulfonyl isomers. The term "alkylsulfonylalkyl" denotes alkylsulfonyl substitution on alkyl. Examples of "alkylsulfonylalkyl" include $CH_3SO_2CH_2$, $CH_3SO_2CH_2CH_2$, $CH_3CH_2SO_2CH_2$ and $CH_3CH_2SO_2CH_2CH_2$. "Alkylthioalkoxy" denotes alkylthio substitution on alkoxy. "Hydroxyalkyl" denotes an alkyl group substituted with one hydroxy group. Examples of hydroxy alkyl include $HOCH_2CH_2CH_2$—, $CH_3CH_2CH(OH)CH_2$—, and CH_3CH_2CHOH—. "Alkylamino", "dialkylamino" and the like, are defined analogously to the above examples.

The term "halogen", either alone or in compound words such as "haloalkyl", or when used in descriptions such as "alkyl substituted with halogen" includes fluorine, chlorine, bromine or iodine. Further, when used in compound words such as "haloalkyl", or when used in descriptions such as "alkyl substituted with halogen" said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of "haloalkyl" or "alkyl substituted with halogen" include F_3C—, $ClCH_2$—, CF_3CH_2— and CF_3CCl_2—. The term "haloalkoxy" and the like, is defined analogously to the term "haloalkyl". Examples of "haloalkoxy" include CF_3O—, CCl_3CH_2O—, $HCF_2CH_2CH_2O$— and CF_3CH_2O—.

The total number of carbon atoms in a substituent group is indicated by the "C_i-C_j" prefix where i and j are numbers from 1 to 4. For example, C_1-C_4 alkylsulfonyl designates methylsulfonyl through butylsulfonyl; C_2 alkoxyalkyl designates CH_3OCH_2—; C_3 alkoxyalkyl designates, for example, $CH_3CH(OCH_3)$—, $CH_3OCH_2CH_2$— or $CH_3CH_2OCH_2$—; and C_4 alkoxyalkyl designates the various isomers of an alkyl group substituted with an alkoxy group containing a total of four carbon atoms, examples including $CH_3CH_2CH_2OCH_2$— and $CH_3CH_2OCH_2CH_2$—.

When a group contains a substituent which can be hydrogen, for example R^2, R^3, R^4, R^5 and R^6, then when this substituent is taken as hydrogen, it is recognized that this is equivalent to said group being unsubstituted. When a variable group is shown to be optionally attached to a position, for example R^8, then hydrogen may be at the position even if not recited in the variable group definition. When one or more positions on a group are said to be "not substituted" or "unsubstituted", then hydrogen atoms are attached to take up any free valency.

Unless otherwise indicated, a "ring" as a component of Formula 1 (e.g., substituent J) is heterocyclic. The term "ring member" refers to an atom or other moiety forming the backbone of a ring. The term "heterocyclic ring" denotes a ring in which at least one atom forming the ring backbone is not carbon, e.g., nitrogen, oxygen or sulfur. Typically a heterocyclic ring contains no more than 4 nitrogens, no more than 2 oxygens and no more than 2 sulfurs. Unless otherwise indicated, a heterocyclic ring can be a saturated, partially unsaturated, or fully unsaturated ring. When a fully unsaturated heterocyclic ring satisfies Hückel's rule, then said ring is also called a "heteroaromatic ring" or "aromatic heterocyclic ring". Unless otherwise indicated, heterocyclic rings and ring systems can be attached through any available carbon or nitrogen by replacement of a hydrogen on said carbon or nitrogen. "Aromatic" indicates that each of the ring atoms is essentially in the same plane and has a p-orbital perpendicular to the ring plane, and that $(4n+2)$ π electrons, where n is a positive integer, are associated with the ring to comply with Hückel's rule.

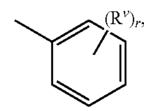
The term "optionally substituted" in connection with the heterocyclic rings refers to groups which are unsubstituted or have at least one non-hydrogen substituent that does not extinguish the biological activity possessed by the unsubstituted analog. As used herein, the following definitions shall apply unless otherwise indicated. The term "optionally substituted" is used interchangeably with the phrase "substituted or unsubstituted" or with the term "(un)substituted." Unless otherwise indicated, an optionally substituted group may have a substituent at each substitutable position of the group, and each substitution is independent of the other.

When J is a 5- or 6-membered nitrogen-containing heterocyclic ring, it may be attached to the remainder of Formula 1 though any available carbon or nitrogen ring atom, unless otherwise described. As noted above, J can be (among others) phenyl optionally substituted with one or more substituents selected from a group of substituents as defined in the Summary of the Invention. An example of phenyl optionally substituted with one to five substituents is the ring illustrated as U-1 in Exhibit 1, wherein R^v is R^7 and R^8 as defined in the Summary of the Invention for substitution on J and r is an integer from 0 to 3 (i.e. substituted with one R^7 and up to two R^8).

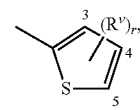
As noted above, J can be phenyl or a 5- or 6-membered aromatic heterocyclic ring, which may be saturated or unsaturated, optionally substituted with one or more substituents selected from a group of substituents as defined in the Summary of the Invention. Examples of a 5- or 6-membered unsaturated aromatic heterocyclic ring optionally substituted with from one or more substituents include the rings U-2 through U-61 illustrated in Exhibit 1 wherein R^v is any substituent as defined in the Summary of the Invention for J (i.e. R^7, R^8, R^9, R^{10} and R^{11}) and r is an integer from 0 to 3, limited by the number of available positions on each U group. As U-29, U-30, U-36, U-37, U-38, U-39, U-40, U-41, U-42 and U-43 have only one available position, for these U groups r is limited to the integers 0 or 1, and r being 0 means that the U group is unsubstituted and a hydrogen is present at the position indicated by $(R^v)_r$.

Exhibit 1

U-1



U-2



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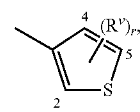

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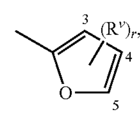

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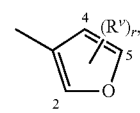

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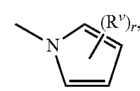

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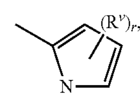

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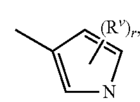

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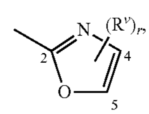

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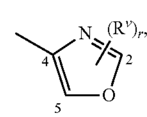

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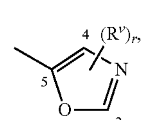

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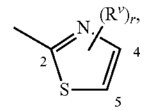
U-12



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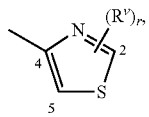

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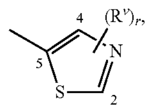

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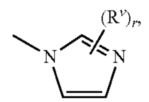

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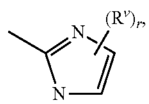
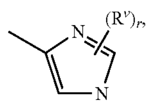
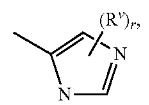


U-17



U-18



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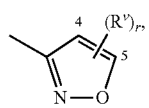

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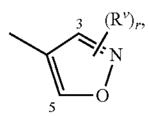

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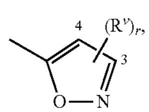

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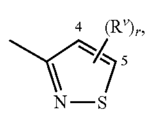

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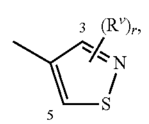

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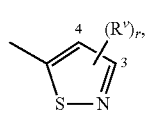

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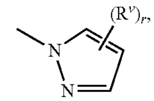

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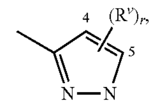

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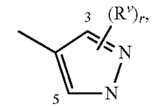

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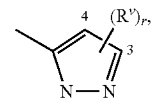

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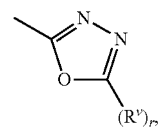

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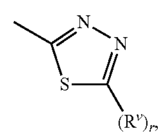

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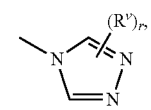

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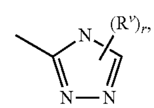

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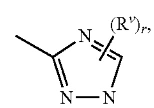

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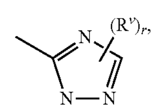

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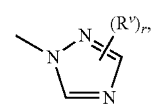

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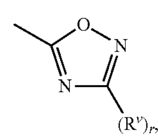

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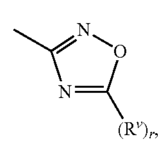

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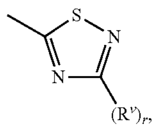

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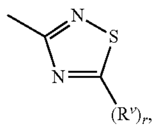

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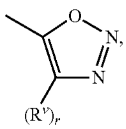

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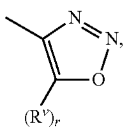

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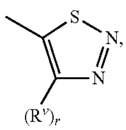

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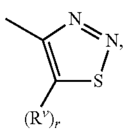

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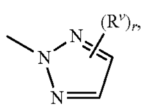

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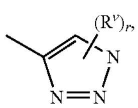

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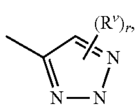

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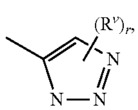

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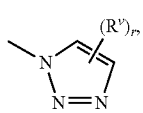

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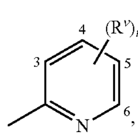

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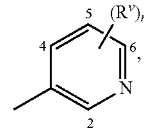

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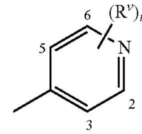

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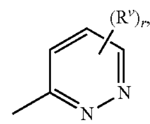

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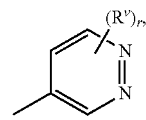

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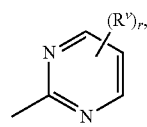

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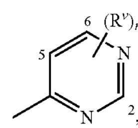

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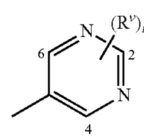

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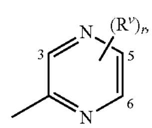

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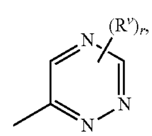

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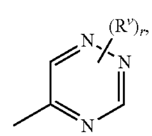

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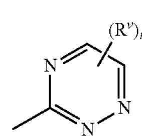

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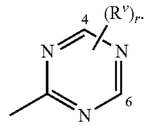
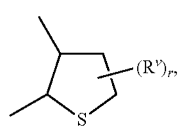


Note that when J is a 5- or 6-membered saturated or unsaturated non-aromatic heterocyclic ring optionally substituted with one or more substituents selected from the group of substituents as defined in the Summary of the Invention for J, one or two carbon ring members of the heterocycle can optionally be in the oxidized form of a carbonyl moiety.

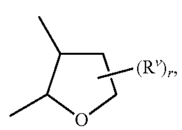
Examples of a 5-membered carbocyclic ring containing ring members selected from up to two O atoms and up to two S atoms, and optionally substituted on carbon atom ring members with up to five halogen atoms includes the rings G-1 through G-5 as illustrated in Exhibit 2 (i.e. when R^7 and R^8 are taken together with two adjacent carbon atoms). Note that when the attachment point on the R^v group is illustrated as floating, the R^v group can be attached to the remainder of Formula 1 through any available carbon G group by replacement of a hydrogen atom. The optional substituents corresponding to R^v can be attached to any available carbon or nitrogen by replacing a hydrogen atom. For these G rings, r is typically an integer from 0 to 5, limited by the number of available positions on each G group.

Exhibit 2

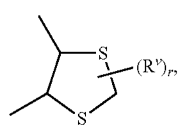
G-1



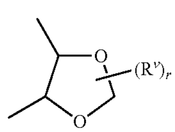
G-2



G-3

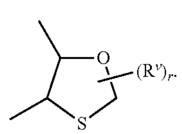


G-4



and

G-5



A wide variety of synthetic methods are known in the art to enable preparation of aromatic and nonaromatic heterocyclic rings and ring systems; for extensive reviews see the eight volume set of *Comprehensive Heterocyclic Chemistry*, A. R. Katritzky and C. W. Rees editors-in-chief, Pergamon Press, Oxford, 1984 and the twelve volume set of *Comprehensive Heterocyclic Chemistry II*, A. R. Katritzky, C. W. Rees and E. F. V. Scriven editors-in-chief, Pergamon Press, Oxford, 1996.

Compounds of this invention can exist as one or more stereoisomers. The various stereoisomers include enantiomers, diastereomers, atropisomers and geometric isomers. One skilled in the art will appreciate that one stereoisomer may be more active and/or may exhibit beneficial effects when enriched relative to the other stereoisomer(s) or when separated from the other stereoisomer(s). Additionally, the skilled artisan knows how to separate, enrich, and/or to selectively prepare said stereoisomers. The compounds of the invention may be present as a mixture of stereoisomers, individual stereoisomers or as an optically active form.

Compounds of Formula 1 typically exist in more than one form, and Formula 1 thus include all crystalline and non-crystalline forms of the compounds they represent. Non-crystalline forms include embodiments which are solids such as waxes and gums as well as embodiments which are liquids such as solutions and melts. Crystalline forms include embodiments which represent essentially a single crystal type and embodiments which represent a mixture of polymorphs (i.e. different crystalline types). The term "polymorph" refers to a particular crystalline form of a chemical compound that can crystallize in different crystalline forms, these forms having different arrangements and/or conformations of the molecules in the crystal lattice. Although polymorphs can have the same chemical composition, they can also differ in composition due the presence or absence of co-crystallized water or other molecules, which can be weakly or strongly bound in the lattice. Polymorphs can differ in such chemical, physical and biological properties as crystal shape, density, hardness, color, chemical stability, melting point, hygroscopicity, suspensibility, dissolution rate and biological availability. One skilled in the art will appreciate that a polymorph of a compound of Formula 1 can exhibit beneficial effects (e.g., suitability for preparation of useful formulations, improved biological performance) relative to another polymorph or a mixture of polymorphs of the same compound of Formula 1. Preparation and isolation of a particular polymorph of a compound of Formula 1 can be achieved by methods known to those skilled in the art including, for example, crystallization using selected solvents and temperatures.

One skilled in the art will appreciate that not all nitrogen-containing heterocycles can form N-oxides since the nitrogen requires an available lone pair for oxidation to the oxide; one skilled in the art will recognize those nitrogen-containing heterocycles which can form N-oxides. One skilled in the art will also recognize that tertiary amines can form N-oxides. Synthetic methods for the preparation of N-oxides of heterocycles and tertiary amines are very well known by one skilled in the art including the oxidation of heterocycles and tertiary amines with peroxy acids such as peracetic and m-chloroperbenzoic acid (MCPBA), hydrogen peroxide, alkyl hydroperoxides such as t-butyl hydroperoxide, sodium perborate, and dioxiranes such as dimethyldioxirane. These methods for the preparation of N-oxides have been extensively described and reviewed in the literature, see for example: T. L. Gilchrist in *Comprehensive Organic Synthesis*, vol. 7, pp 748-750, S. V. Ley, Ed., Pergamon Press; M. Tisler and B. Stanovnik in *Comprehensive Heterocyclic Chemistry*, vol. 3, pp 18-20, A. J. Boulton and A. McKillop, Eds., Pergamon Press; M. R. Grimmett and B. R. T. Keene in *Advances in Heterocyclic Chemistry*, vol. 43, pp 149-161, A. R. Katritzky, Ed., Academic Press; M. Tisler and B. Stanovnik in *Advances in Heterocyclic Chemistry*, vol. 9, pp 285-291, A. R. Katritzky and A. J. Boulton, Eds., Academic Press; and G. W. H. Cheeseman and E. S. G. Werstiuk in *Advances in Heterocyclic Chemistry*, vol. 22, pp 390-392, A. R. Katritzky and A. J. Boulton, Eds., Academic Press.

One skilled in the art recognizes that because in the environment and under physiological conditions salts of chemical compounds are in equilibrium with their corresponding nonsalt forms, salts share the biological utility of the nonsalt forms. Thus a wide variety of salts of a compound of Formula 1 are useful for control of undesired vegetation (i.e. are agriculturally suitable). The salts of a compound of Formula 1 include acid-addition salts with inorganic or organic acids such as hydrobromic, hydrochloric, nitric, phosphoric, sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric acids. When a compound of Formula 1 contains an acidic moiety such as a carboxylic acid or phenol, salts also include those formed with organic or inorganic bases such as pyridine, triethylamine or ammonia, or amides, hydrides, hydroxides or carbonates of sodium, potassium, lithium, calcium, magnesium or barium. Accordingly, the present invention comprises compounds selected from Formula 1, N-oxides and agriculturally suitable salts thereof.

Embodiments of the present invention as described in the Summary of the Invention include (where Formula 1 as used in the following Embodiments includes N-oxides and salts thereof) the following:

Embodiment 1

A compound of Formula 1 (including all stereoisomers), N-oxides, and salts thereof, agricultural compositions containing them and their use as herbicides as described in the Summary of the Invention.

Embodiment 1A

A compound of Formula 1 wherein R^1 is H, halogen, cyano, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy, C_1-C_4 hydroxyalkyl, $SO_n(R^{12})$, C_2-C_4 alkylthioalkyl, C_2-C_4 alkylsulfonylalkyl, C_1-C_4 alkylamino or C_2-C_4 dialkylamino.

Embodiment 1B

A compound of Embodiment 1A wherein R^1 is other than H,

Embodiment 1C

A compound of Embodiment 1 wherein R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy, C_2-C_6 alkylcarbonyloxy, C_1-C_4 hydroxyalkyl, $SO_n(R^{12})$, C_2-C_4 alkylthioalkyl or C_2-C_4 alkylsulfonylalkyl.

Embodiment 2

A compound of Embodiment 1 or 1C wherein R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy, C_1-C_4 hydroxyalkyl, $SO_n(R^{12})$, C_2-C_4 alkylthioalkyl or C_2-C_4 alkylsulfonylalkyl.

Embodiment 3

A compound of Embodiment 2 wherein R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl or C_2-C_4 alkenyl.

Embodiment 4

A compound of Embodiment 3 wherein R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl or C_1-C_4 haloalkyl.

Embodiment 5

A compound of Embodiment 4 wherein R^1 is C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or C_1-C_4 alkyl.

Embodiment 6

A compound of Embodiment 5 wherein R^1 is C_1-C_4 alkoxy or C_1-C_4 alkyl.

Embodiment 7

A compound of Embodiment 6 wherein R^1 is C_1-C_4 alkyl.

Embodiment 7A

A compound of Embodiment 7 wherein R^1 is C_1-C_3 alkyl.

Embodiment 7B

A compound of Embodiment 7 wherein R^1 is C_1-C_2 alkyl.

Embodiment 8

A compound of Embodiment 7 wherein R^1 is CH_3.

Embodiment 8A

A compound of Embodiment 5 wherein R^1 is CH_3CH_2O—, CH_3O—, CF_3CH_2O— or CH_3.

Embodiment 8B

A compound of Embodiment 5 wherein R^1 is CH_3CH_2O—, CH_3O— or CH_3.

Embodiment 8C

A compound of Embodiment 5 wherein R^1 is CH_3CH_2O— or CH_3O—,

Embodiment 8D

A compound of Embodiment 5 wherein R^1 is CH_3CH_2O—.

Embodiment 9

A compound of any one of Embodiments 1 through 8D wherein A is a radical selected from the group consisting of A-1 and A-2.

Embodiment 10

A compound of Embodiment 9 wherein A is A-1.

Embodiment 11

A compound of Embodiment 10 wherein each Y^1, Y^3, Y^4 and Y^5 is independently N or CR^2; and Y^2 is CR^2.

Embodiment 12

A compound of Embodiment 11 wherein each Y^1 and Y^5 is independently N or CR^2; and each Y^2, Y^3 and Y^4 is CR^2.

Embodiment 13

A compound of Embodiment 12 wherein Y^1 is N or CR^2; and each Y^2, Y^3, Y^4 and Y^5 is independently CR^2.

Embodiment 14

A compound of Embodiment 13 wherein Y^1 is N; and each Y^2, Y^3, Y^4 and Y^5 is independently CR^2.

Embodiment 15

A compound of Embodiment 14 wherein Y^1 is N; each Y^2, Y^3 and Y^4 is CH; and Y^5 is CF.

Embodiment 16

A compound of Embodiment 13 wherein each Y^1, Y^2, Y^3 and Y^4 and is CH; and Y^5 is CCF_3 or CF.

Embodiment 17

A compound of Embodiment 9 wherein A is A-2.

Embodiment 18

A compound of Embodiment 17 wherein each Y^6 and Y^7 is independently N or CR^3; and Y^8 is CR^3.

Embodiment 19

A compound of Embodiment 18 wherein each Y^6 and Y^7 is N; and Y^8 is CR^3.

Embodiment 20

A compound of Embodiment 19 wherein each Y^6 and Y^7 is N; and Y^8 is CH.

Embodiment 21

A compound of any one of Embodiments 1 through 9 or 17 through 20 wherein Z is S.

Embodiment 22

A compound of any one of Embodiments 1 through 21 wherein Q is $C(R^4)(R^5)$, O or S.

Embodiment 23

A compound of Embodiment 22 wherein Q is $C(R^4)(R^5)$ or O.

Embodiment 24

A compound of Embodiment 23 wherein Q is $C(R^4)(R^5)$.

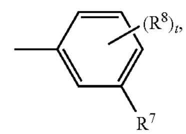
Embodiment 25

A compound of Embodiment 23 wherein Q is O.

Embodiment 26

A compound of any one of Embodiments 1 through 25 wherein J is selected from

J-1



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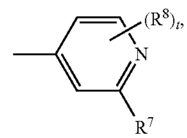

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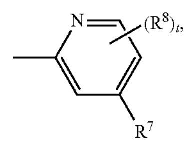

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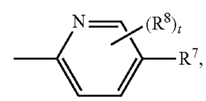

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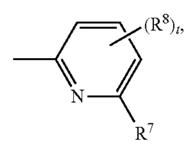

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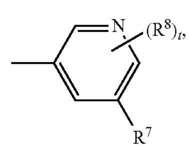

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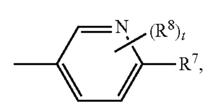

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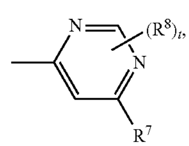

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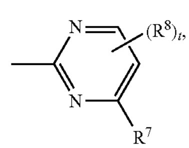

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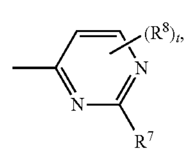

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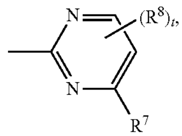

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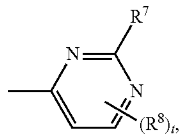

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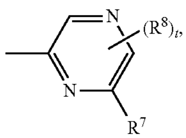

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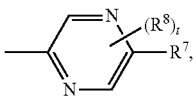

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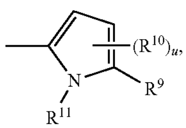

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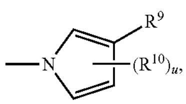

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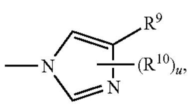

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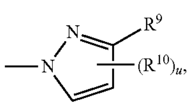

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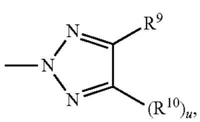

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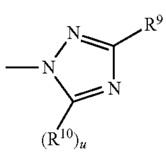

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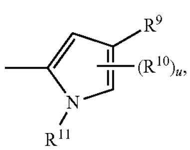

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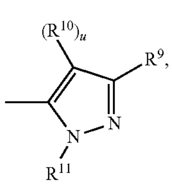

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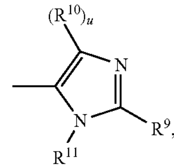

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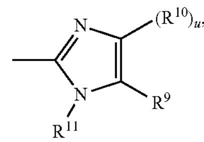

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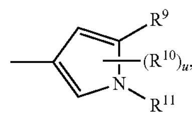

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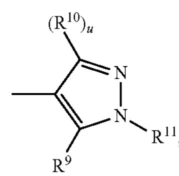

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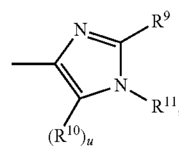

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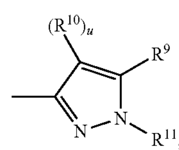

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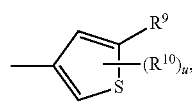

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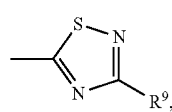

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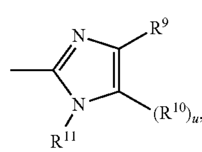
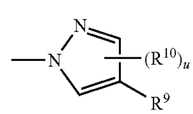
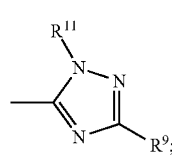


J-32



and

J-33



t is 0, 1 or 2; and
u is 0 or 1.

Embodiment 27

A compound of Embodiment 26 wherein J is selected from J-1 through J-14 (i.e. J is a 6-membered aromatic heterocyclic ring selected from J-1 through J-14).

Embodiment 28

A compound of Embodiment 26 wherein J is selected from J-15 through J-33 (i.e. J is a 5-membered aromatic heterocyclic ring selected from J-15 through J-33).

Embodiment 29

A compound of Embodiment 26 wherein J is selected from J-1, J-2, J-3, J-4, J-5, J-6, J-7, J-9, J-12, J-17, J-18, J-20, J-22, J-26, J-29 and J-30 (i.e. all J groups prepared in Index Table A).

Embodiment 30

A compound of Embodiment 27 or 29 wherein J is selected from J-1, J-2, J-3, J-4, J-5, J-6, J-7, J-9 and J-12 (i.e. all 6-membered J groups prepared in Index Table A).

Embodiment 30A

A compound of Embodiment 27 or 29 wherein J is selected from J-2, J-3, J-4, J-5, J-6 and J-7 (i.e. all pyridine J groups).

Embodiment 30B

A compound of Embodiment 27 or 29 wherein J is selected from J-8, J-9, J-10, J-11, J-12, J-13 and J-14 (i.e. all pyrimidine J groups).

Embodiment 31

A compound of Embodiment 28 or 29 wherein J is selected from J-18, J-20, J-22, J-26, J-29 and J-30 (i.e. all 5-membered J groups prepared in Index Table A).

Embodiment 31A

A compound of Embodiment 28 wherein J is selected from J-15, J-21, J-22, J-23, J-24, J-25, J-26, J-27, J-28, J-31 and J-33 (i.e. all nitrogen containing 5-membered J groups linked through carbon).

Embodiment 31B

A compound of Embodiment 28 wherein J is selected from J-16, J-17, J-18, J-19, J-20 and J-32 (i.e. all nitrogen containing 5-membered J groups linked through nitrogen).

Embodiment 32

A compound of Embodiment 26 wherein J is selected from J-1, J-2, J-10, J-17, J-18 and J-20.

Embodiment 33

A compound of Embodiment 32 wherein J is selected from J-1, J-2, J-17 and J-18.

Embodiment 34

A compound of Embodiment 33 wherein J is J-1.

Embodiment 35

A compound of Embodiment 33 wherein J is J-2.

Embodiment 35A

A compound of any one of Embodiments 26, 27, 29, 30, 30A, 30B, 32 or 33 wherein t is 0 or 1.

Embodiment 35B

A compound of Embodiment 35A wherein t is 0.

Embodiment 35C

A compound of any one of Embodiments 26, 28, 29, 31, 31A, 31B, 32 or 33 wherein u is 0.

Embodiment 36

A compound of any one of Embodiments 1 through 26, 27, 29, 30 or 32 through 34 wherein J is other than J-1.

Embodiment 37

A compound of any one of Embodiments 1 through 36 wherein each R^2 is independently H, halogen, C_1-C_4 alkoxy, C_1-C_4 alkyl or C_1-C_4 haloalkyl.

Embodiment 38

A compound of Embodiment 37 wherein each R^2 is independently H, halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl.

Embodiment 39

A compound of Embodiment 38 wherein each R^2 is independently H, F, Cl, CH_3 or CF_3.

Embodiment 40

A compound of Embodiment 39 wherein each R^2 is independently H, F, Cl or CF_3.

Embodiment 41

A compound of Embodiment 40 wherein each R^2 is independently H or CF_3.

Embodiment 42

A compound of Embodiment 40 wherein each R^2 is independently H or F.

Embodiment 43

A compound of any one of Embodiments 1 through 42 wherein each R^3 is independently H, halogen or C_1-C_4 haloalkyl.

Embodiment 44

A compound of Embodiment 43 wherein each R^3 is independently H, F, Cl or CF_3.

Embodiment 45

A compound of Embodiment 44 wherein each R^3 is independently H or CF_3.

Embodiment 45A

A compound of any one of Embodiments 1 through 45 wherein R^4 is taken alone.

Embodiment 46

A compound of any one of Embodiments 1 through 45A wherein R^4 is H, F, Cl, Br or C_1-C_4 alkyl.

Embodiment 47

A compound of Embodiment 46 wherein R^4 is H, F or CH_3.

Embodiment 48

A compound of Embodiment 47 wherein R^4 is H.

Embodiment 48A

A compound of any one of Embodiments 1 through 48 wherein R^5 is taken alone.

Embodiment 49

A compound of any one of Embodiments 1 through 48A wherein R^5 is H, F or OH.

Embodiment 50

A compound of Embodiment 49 wherein R^5 is H or F.

Embodiment 51

A compound of Embodiment 50 wherein R^5 is H.

Embodiment 52

A compound of Embodiment 50 wherein R^5 is F.

Embodiment 53

A compound of any one of Embodiments 1 through 45 wherein R^4 and R^5 are taken together with the carbon to which they are attached to form C(=O).

Embodiment 54

A compound of any one of Embodiments 1 through 53 wherein R^6 is H or C_1-C_4 alkyl.

Embodiment 55

A compound of Embodiment 54 wherein R^6 is CH_3.

Embodiment 56

A compound of Embodiment 54 wherein R^6 is H.

Embodiment 56A

A compound of any one of Embodiments 1 through 56 wherein R^7 is taken alone.

Embodiment 57

A compound of any one of Embodiments 1 through 56A wherein R^7 is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy.

Embodiment 58

A compound of Embodiment 57 wherein R^7 is halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl.

Embodiment 59

A compound of Embodiment 58 wherein R^7 is F, CH_3 or CF_3.

Embodiment 60

A compound of Embodiment 59 wherein R^7 is F or CF_3.

Embodiment 61

A compound of Embodiment 60 wherein R^7 is F.

Embodiment 62

A compound of Embodiment 60 wherein R^7 is CF_3.

Embodiment 62A

A compound of any one of Embodiments 1 through 62 wherein each R^8 is taken alone.

Embodiment 63

A compound of any one of Embodiments 1 through 62A wherein each R^8 is independently halogen or C_1-C_4 haloalkyl.

Embodiment 64

A compound of Embodiment 63 wherein each R^8 is independently F, Cl or CF_3.

Embodiment 65

A compound of Embodiment 63 wherein each R^8 is F.

Embodiment 66

A compound of any one of Embodiments 1 through 56 wherein R^7 and R^8 are taken together with two adjacent carbon atoms to form a 5-membered ring containing ring members selected from carbon atoms and up to two O atoms, and optionally substituted on carbon atom ring members with up to five halogen atoms.

Embodiment 67

A compound of Embodiment 66 wherein R^7 and R^8 are taken together with two adjacent carbon atoms to form a 5-membered ring containing ring members selected from carbon atoms and up to two O atoms, and optionally substituted on carbon atom ring members with up to two halogen atoms.

Embodiment 68

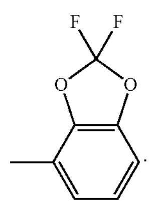
A compound of Embodiment 67 wherein R^7 and R^8 are taken together with two adjacent carbon atoms to form a

5-membered ring containing ring members selected from carbon atoms and up to two O atoms, and substituted on carbon atom ring members with up to two F atoms.

Embodiment 69

A compound of Embodiment 68 wherein R^7 and R^8 are taken together with two adjacent carbon atoms to form a 2,2-difluorodioxolane ring (i.e. J is J-1B)

J-1B



Embodiment 70

A compound of any one of Embodiments 1 through 69 wherein R^9 is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy.

Embodiment 71

A compound of Embodiment 70 wherein R^9 is halogen, C_1-C_4 alkyl C_1-C_4 haloalkyl or C_1-C_4 alkoxy.

Embodiment 72

A compound of Embodiments 71 wherein R^9 is halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl.

Embodiment 73

A compound of Embodiment 72 wherein R^9 is F, CH_3 or CF_3.

Embodiment 74

A compound of Embodiment 73 wherein R^9 is F or CF_3.

Embodiment 75

A compound of Embodiment 74 wherein R^9 is F.

Embodiment 76

A compound of Embodiment 74 wherein R^9 is CF_3.

Embodiment 77

A compound of any one of Embodiments 1 through 76 wherein R^{10} is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy.

Embodiment 78

A compound of Embodiment 77 wherein R^{10} is halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl.

Embodiment 79

A compound of Embodiment 78 wherein R^{10} is F, CH_3 or CF_3.

Embodiment 80

A compound of Embodiment 79 wherein R^{10} is F or CF_3.

Embodiment 81

A compound of Embodiment 80 wherein R^{10} is F.

Embodiment 82

A compound of Embodiment 80 wherein R^{10} is CF_3.

Embodiment 83

A compound of any one of Embodiments 1 through 82 wherein R^{11} is C_1-C_4 alkyl or C_1-C_4 haloalkyl.

Embodiment 84

A compound of Embodiment 83 wherein R^{11} is C_1-C_4 alkyl.

Embodiment 85

A compound of Embodiment 84 wherein R^{11} is CH_3.

Embodiment 86

A compound of any one of Embodiments 1 through 85 wherein each R^{12} is independently C_1-C_4 alkyl.

Embodiment 87

A compound of Embodiment 86 wherein each R^{12} is CH_3.

Embodiment 88

A compound of any one of Embodiments 1 through 87 wherein each R^{13} is independently CH_3 or CH_2CH_3.

Embodiment 89

A compound of Embodiment 88 wherein each R^{13} is CH_3.

Embodiment 90

A compound of any one of Embodiments 1 through 89 wherein R^{14} is C_1-C_4 alkyl.

Embodiment 91

A compound of Embodiment 90 wherein R^{14} is CH_3.

Embodiment 92

A compound of any one of Embodiments 1 through 91 wherein R^{15} is C_1-C_4 alkyl.

Embodiment 93

A compound of Embodiment 92 wherein R^{15} is CH_3.

Embodiment 94

A compound of any one of Embodiments 1 through 93 wherein n is 0 or 2.

Embodiment 95

A compound of Embodiment 94 wherein n is 0.

Embodiment 96

A compound of Embodiment 94 wherein n is 2.

Embodiments of this invention, including Embodiments 1-96 above as well as any other embodiments described herein, can be combined in any manner, and the descriptions of variables in the embodiments pertain not only to the compounds of Formula 1 but also to the starting compounds and intermediate compounds useful for preparing the compounds of Formula 1. In addition, embodiments of this invention, including Embodiments 1-96 above as well as any other embodiments described herein, and any combination thereof, pertain to the compositions and methods of the present invention.

Embodiment A

A compound of the Summary of the Invention wherein

R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy, C_2-C_6 alkylcarbonyloxy, C_1-C_4 hydroxyalkyl, $SO_n(R^{12})$, C_2-C_4 alkylthioalkyl or C_2-C_4 alkylsulfonylalkyl;

A is a radical selected from the group consisting of A-1 and A-2;

each Y^1, Y^3, Y^4 and Y^5 is independently N or CR^2; and Y^2 is CR^2;

each Y^6 and Y^7 is independently N or CR^3; and Y^8 is CR^3;

Z is S;

Q is $C(R^4)(R^5)$, O or S;

J is selected from J-1 through J-33;

t is 0, 1 or 2;

u is 0;

each R^2 is independently H, halogen, C_1-C_4 alkoxy, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^3 is independently H, halogen or C_1-C_4 haloalkyl

R^4 is H, F, Cl, Br or C_1-C_4 alkyl;

R^5 is H, F or OH; or

R^4 and R^5 are taken together with the carbon to which they are attached to form C(═O);

R^7 is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy;

R^8 is independently halogen or C_1-C_4 haloalkyl; or

R^7 and R^8 are taken together with two adjacent carbon atoms to form a 2,2-difluorodioxolane ring;

R^9 is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy;

R^{10} is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy;

R^{11} is C_1-C_4 alkyl or C_1-C_4 haloalkyl

each R^{12} is independently C_1-C_4 alkyl;

each R^{13} is independently CH_3 or CH_2CH_3;

R^{14} is C_1-C_4 alkyl;

R^{15} is C_1-C_4 alkyl; and

n is O or 2.

Embodiment B

A compound of Embodiment A wherein

R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl or C_2-C_4 alkenyl;

each Y^1 and Y^5 is independently N or CR^2; and each Y^2, Y^3 and Y^4 is CR^2;

each Y^6 and Y^7 is N; and Y^8 is CR^3;

Q is $C(R^4)(R^5)$ or O;

J is selected from J-1, J-2, J-3, J-4, J-5, J-6, J-7, J-9, J-12, J-17, J-18, J-20, J-22, J-26, J-29 and J-30;

t is 0 or 1;

u is 0;

each R^2 is independently H, halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^3 is independently H, F, Cl or CF_3;

R^4 is H, F or CH_3;

R^5 is H or F;

R^7 is F, CH_3 or CF_3;

R^8 is independently F, Cl or CF_3;

R^9 is halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^{10} is halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^{11} is C_1-C_4 alkyl;

each R^{12} is CH_3; and

each R^{13} is CH_3.

Embodiment C

A compound of Embodiment A wherein

R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

A is A-1;

Y^1 is N or CR^2; and each Y^2, Y^3, Y^4 and Y^5 is independently CR^2;

Q is $C(R^4)(R^5)$;

J is selected from J-1, J-2, J-10, J-17, J-18 and J-20;

t is 0;

each R^2 is independently H, F, Cl, CH_3 or CF_3;

R^4 is H;

R^5 is H; and

R^7 is F or CF_3.

Embodiment D

A compound of Embodiment B wherein

R^1 is C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or C_1-C_4 alkyl;

A is A-1;

Y^1 is N or CR^2; and each Y^2, Y^3, Y^4 and Y^5 is independently CR^2;

Q is O;

J is selected from J-1, J-2, J-17 and J-18;

each R^2 is independently H, F, Cl or CF_3; and

R^7 is CF_3.

Embodiment E

A compound of Embodiment D wherein

R^1 is CH_3;

each Y^1, Y^2, Y^3, Y^4 and Y^5 is independently CR^2;

J is J-2;

t is 0; and

each R^2 is independently H or F.

Specific embodiments include compounds of Formula 1 selected from the group consisting of:

4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]oxy]-2-(trifluoromethyl)pyridine (Compound 129) and

4-[[5-Methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 15).

Specific embodiments also include compounds of Formula 1 selected from the group consisting of:

4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 16);

4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]oxy]-2-(trifluoromethyl)pyridine (Compound 129);

4-[[5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 196);

4-[[5-methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 15);

4-[[5-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 47);

4-[[5-ethoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 164); and

4-[[5-(2,2,2-trifluoroethoxy)-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 14).

Specific embodiments also include compounds of Formula 1 selected from the group consisting of:

Compound 16, Compound 129, Compound 196, Compound 15 and Compound 47.

Specific embodiments also include compounds of Formula 1 selected from the group consisting of:

Compound 16, Compound 129 and Compound 196.

This invention also relates to a method for controlling undesired vegetation comprising applying to the locus of the vegetation herbicidally effective amounts of the compounds of the invention (e.g., as a composition described herein). Of note as embodiments relating to methods of use are those involving the compounds of embodiments described above. Compounds of the invention are particularly useful for selective control of weeds in cereal crops such as wheat, barley, maize, soybean, sunflower, cotton, oilseed rape and rice, and specialty crops such as sugarcane, citrus, fruit and nut crops.

Also noteworthy as embodiments are herbicidal compositions of the present invention comprising the compounds as described in the embodiments above.

This invention also includes a herbicidal mixture comprising (a) a compound selected from Formula 1, N-oxides, and salts thereof, and (b) at least one additional active ingredient selected from (b1) photosystem II inhibitors, (b2) acetohydroxy acid synthase (AHAS) inhibitors, (b3) acetyl-CoA carboxylase (ACCase) inhibitors, (b4) auxin mimics and (b5) 5-enol-pyruvylshikimate-3-phosphate (EPSP) synthase inhibitors, (b6) photosystem I electron diverters, (b7) protoporphyrinogen oxidase (PPO) inhibitors, (b8) glutamine synthetase (GS) inhibitors, (b9) very long chain fatty acid (VLCFA) elongase inhibitors, (b10) auxin transport inhibitors, (b11) phytoene desaturase (PDS) inhibitors, (b12) 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitors, (b13) homogentisate solenesyltransererase (HST) inhibitors, (b14) cellulose biosynthesis inhibitors, (b15) other herbicides including mitotic disruptors, organic arsenicals, asulam, difenzoquat, bromobutide, flurenol, cinmethylin, cumyluron, dazomet, dymron, methyldymron, etobenzanid, fosamine, fosamine-ammonium, metam, oxaziclomefone, oleic acid, pelargonic acid and pyributicarb, and (b16) herbicide safeners; and salts of compounds of (b1) through (b16).

"Photosystem II inhibitors" (b1) are chemical compounds that bind to the D-1 protein at the Q_B-binding niche and thus block electron transport from Q_A to Q_B in the chloroplast thylakoid membranes. The electrons blocked from passing through photosystem II are transferred through a series of reactions to form toxic compounds that disrupt cell membranes and cause chloroplast swelling, membrane leakage, and ultimately cellular destruction. The Q_B-binding niche has three different binding sites: binding site A binds the triazines such as atrazine, triazinones such as hexazinone, and uracils such as bromacil, binding site B binds the phenylureas such as diuron, and binding site C binds benzothiadiazoles such as bentazon, nitriles such as bromoxynil and phenyl-pyridazines such as pyridate. Examples of photosystem II inhibitors include ametryn, atrazine, cyanazine, desmetryne, dimethametryn, prometon, prometryne, propazine, simazine, simetryn, terbumeton, terbuthylazine, terbutryne, trietazine, hexazinone, metamitron, metribuzin, amicarbazone, bromacil, lenacil, terbacil, chloridazon, desmedipham, phenmedipham, chlorobromuron, chlorotoluron, chloroxuron, dimefuron, diuron, ethidimuron, fenuron, fluometuron, isoproturon, isouron, linuron, methabenzthiazuron, metobromuron, metoxuron, monolinuron, neburon, siduron, tebuthiuron, propanil, pentanochlor, bromofenoxim, bromoxynil, ioxynil, bentazon, pyridate and pyridafol.

"AHAS inhibitors" (b2) are chemical compounds that inhibit acetohydroxy acid synthase (AHAS), also known as acetolactate synthase (ALS), and thus kill plants by inhibiting the production of the branched-chain aliphatic amino acids such as valine, leucine and isoleucine, which are required for DNA synthesis and cell growth. Examples of AHAS inhibitors include amidosulfuron, azimsulfuron, bensulfuron-methyl (b2a), chlorimuron-ethyl, chlorsulfuron, cinosulfuron, cyclosulfamuron, ethametsulfuron-methyl, ethoxysulfuron, flazasulfuron, flupyrsulfuron-methyl (b2b), flupyrsulfuron-sodium, foramsulfuron, halosulfuron-methyl, imazosulfuron, iodosulfuron-methyl (including sodium salt), mesosulfuron-methyl, metazosulfuron, metsulfuron-methyl, nicosulfuron, oxasulfuron, primisulfuron-methyl, propyrisulfuron, prosulfuron, pyrazosulfuron-ethyl, rimsulfuron, sulfometuron-methyl, sulfosulfuron, thifensulfuron-methyl (b2c), triasulfuron, tribenuron-methyl, trifloxysulfuron (including sodium salt), triflusulfuron-methyl, tritosulfuron, imazapic, imazamethabenz-methyl, imazamox, imazapyr, imazaquin, imazethapyr, cloransulam-methyl, diclosulam, florasulam, flumetsulam, metosulam, penoxsulam, bispyribac-sodium, pyribenzoxim, pyriftalid, pyrithiobac-sodium, pyriminobac-methyl, thiencarbazone, flucarbazone-sodium and propoxycarbazone-sodium.

"ACCase inhibitors" (b3) are chemical compounds that inhibit the acetyl-CoA carboxylase enzyme, which is responsible for catalyzing an early step in lipid and fatty acid synthesis in plants. Lipids are essential components of cell membranes, and without them, new cells cannot be produced. The inhibition of acetyl CoA carboxylase and the subsequent lack of lipid production leads to losses in cell membrane integrity, especially in regions of active growth such as meristems. Eventually shoot and rhizome growth ceases, and shoot meristems and rhizome buds begin to die back. Examples of ACCase inhibitors include cyclopyrimorate, clodinafop, cyhalofop, diclofop, fenoxaprop, fluazifop, haloxyfop, propaquizafop, quizalofop, alloxydim, butroxydim, clethodim, cycloxydim, pinoxaden, profoxydim, sethoxydim, tepraloxydim and tralkoxydim, including resolved forms such as fenoxaprop-P, fluazifop-P, haloxyfop-P and quizalofop-P and ester forms such as clodinafop-propargyl, cyhalofop-butyl, diclofop-methyl and fenoxaprop-P-ethyl.

Auxin is a plant hormone that regulates growth in many plant tissues. "Auxin mimics" (b4) are chemical compounds mimicking the plant growth hormone auxin, thus causing uncontrolled and disorganized growth leading to plant death in susceptible species. Examples of auxin mimics include aminocyclopyrachlor and its methyl and ethyl esters and its sodium and potassium salts, aminopyralid benazolin-ethyl, chloramben, clacyfos, clomeprop, clopyralid, dicamba, 2,4-D, 2,4-DB, dichlorprop, fluroxypyr, halauxifen, halauxifen-methyl, mecoprop, MCPA, MCPB, 2,3,6-TBA, picloram, triclopyr, quinclorac and quinmerac.

"EPSP (5-enol-pyruvylshikimate-3-phosphate) synthase inhibitors" (b5) are chemical compounds that inhibit the enzyme, 5-enol-pyruvylshikimate-3-phosphate synthase, which is involved in the synthesis of aromatic amino acids such as tyrosine, tryptophan and phenylalanine EPSP inhibitor herbicides are readily absorbed through plant foliage and translocated in the phloem to the growing points. Glyphosate is a relatively nonselective postemergence herbicide that belongs to this group. Glyphosate includes esters and salts such as ammonium, isopropylammonium, potassium, sodium (including sesquisodium) and trimesium (alternatively named sulfosate).

"Photosystem I electron diverters" (b6) are chemical compounds that accept electrons from Photosystem I, and after several cycles, generate hydroxyl radicals. These radicals are extremely reactive and readily destroy unsaturated lipids, including membrane fatty acids and chlorophyll. This destroys cell membrane integrity, so that cells and organelles "leak", leading to rapid leaf wilting and desiccation, and eventually to plant death. Examples of this second type of photosynthesis inhibitor include paraquat and diquat.

"PPO inhibitors" (b7) are chemical compounds that inhibit the enzyme protoporphyrinogen oxidase, quickly resulting in formation of highly reactive compounds in plants that rupture cell membranes, causing cell fluids to leak out. Examples of PPO inhibitors include acifluorfen-sodium, bifenox, chlomethoxyfen, fluoroglycofen-ethyl, fomesafen, halosafen, lactofen, oxyfluorfen, fluazolate, pyraflufen-ethyl, cinidon-ethyl, flumioxazin, flumiclorac-pentyl, fluthiacet-methyl, thidiazimin, oxadiazon, oxadiargyl, saflufencil, azafenidin, carfentrazone carfentrazone-ethyl, sulfentrazone, pentoxazone, benzfendizone, butafenacil, pyraclonil, profluazol, flufenpyr-ethyl and tiafenacil.

"GS (glutamine synthase) inhibitors" (b8) are chemical compounds that inhibit the activity of the glutamine synthetase enzyme, which plants use to convert ammonia into glutamine. Consequently, ammonia accumulates and glutamine levels decrease. Plant damage probably occurs due to the combined effects of ammonia toxicity and deficiency of amino acids required for other metabolic processes. The GS inhibitors include glufosinate and its esters and salts such as glufosinate-ammonium and other phosphinothricin derivatives, glufosinate-P and bilanaphos.

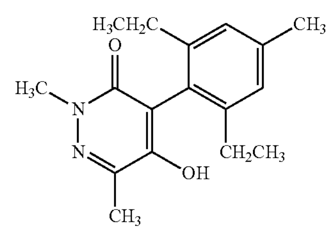
"VLCFA (very long chain fatty acid) elongase inhibitors" (b9) are herbicides having a wide variety of chemical structures, which inhibit the elongase. Elongase is one of the enzymes located in or near chloroplasts which are involved in biosynthesis of VLCFAs. In plants, very-long-chain fatty acids are the main constituents of hydrophobic polymers that prevent desiccation at the leaf surface and provide stability to pollen grains. Such herbicides include acetochlor, alachlor, butachlor, dimethachlor, dimethanamid, metazachlor, metolachlor, pethoxamid, pretilachlor, propachlor, propisochlor, pyroxasulfone, thenylchlor, diphenamid, napropamide, naproanilide, fenoxasulfone, flufenacet, indanofan, mefenacet, fentrazamide, anilofos, cafenstrole, piperophos including resolved forms such as S-metolachlor and chloroacetamides and oxyacetamides.

"Auxin transport inhibitors" (b10) are chemical substances that inhibit auxin transport in plants, such as by binding with an auxin-carrier protein. Examples of auxin transport inhibitors include naptalam (also known as N-(1-naphthyl)phthalamic acid and 2-[(1-naphthalenylamino)carbonyl]benzoic acid) and diflufenzopyr.

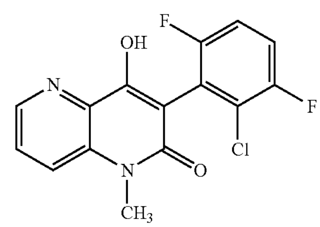
"PDS (phytoene desaturase inhibitors) (b11) are chemical compounds that inhibit carotenoid biosynthesis pathway at the phytoene desaturase step. Examples of PDS inhibitors include norflurzon, diflufenican, picolinafen, beflubutamide, fluridone, flurochloridone and flurtamone.

"HPPD (4-hydroxyphenyl-pyruvate dioxygenase) inhibitors" (b12) are chemical substances that inhibit the biosynthesis of synthesis of 4-hydroxyphenyl-pyruvate dioxygenase. Examples of HPPD inhibitors include mesotrione, sulcotrione, topramezone, tembotrione, tefuryltrione, isoxachlortole, isoxaflutole, benzofenap, pyrasulfatole, pyrazolynate, pyrazoxyfen, bicyclopyrone, benzobicyclon, fenquinotrione and 5-[(2-hydroxy-6-oxo-1-cyclohexen-1-yl)carbonyl]-2-(3-methoxyphenyl)-3-(3-methoxypropyl)-4(3H)-pyrimidinone (b12a).

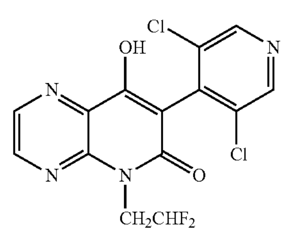
HST (homogentisate solenesyltransererase) inhibitors (b13) disrupt a plant's ability to convert homogentisate to 2-methyl-6-solanyl-1,4-benzoquinone, thereby disrupting carotenoid biosynthesis. Examples of HST inhibitors include haloxydine, pyriclor and the compounds of Formulae A, B and C.



A



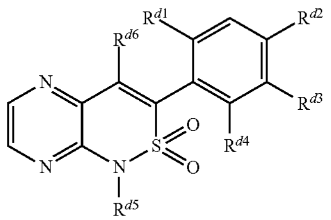
B



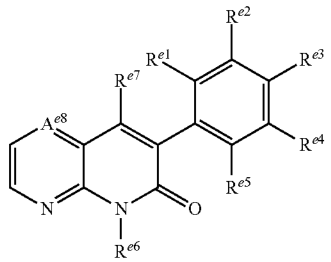
C

HST inhibitors also include compounds of Formulae D and E.

D



E



wherein R^{d1} is H, Cl or CF_3; R^{d2} is H, Cl or Br; R^{d3} is H or Cl; R^{d4} is H, Cl or CF_3; R^{d5} is CH_3, CH_2CH_3 or CH_2CHF_2; and R^{d6} is OH, or —OC(═O)-i-Pr; and R^{e1} is H, F, Cl, CH_3 or CH_2CH_3; R^{e2} is H or CF_3; R^{e3} is H, CH_3 or CH_2CH_3; R^{e4} is H, F or Br; R^{e5} is Cl, CH_3, CF_3, OCF_3 or CH_2CH_3; R^{e6} is H, CH_3, CH_2CHF_2 or C≡CH; R^{e7} is OH, —OC(═O)Et, —OC(═O)-i-Pr or —OC(═O)-t-Bu; and A^{e8} is N or CH.

Cellulose biosynthesis inhibitors (b14) inhibit the biosynthesis of cellulose in certain plants. They are most effective when using a pre-application or early post-application on young or rapidly growing plants. Examples of cellulose biosynthesis inhibitors include chlorthiamid, diclobenil, flupoxam, indaziflam, isoxaben and triaziflam.

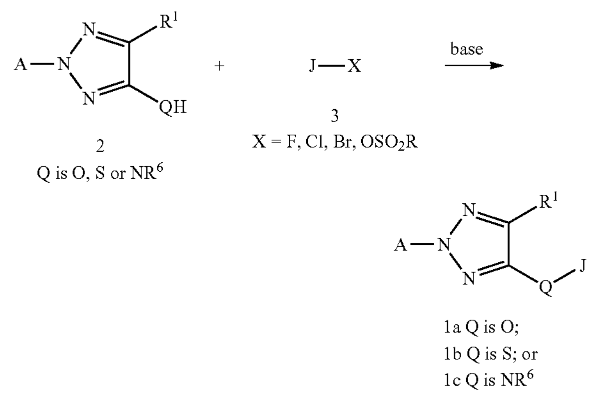
Other herbicides (b15) include herbicides that act through a variety of different modes of action such as mitotic disruptors (e.g., flamprop-M-methyl and flamprop-M-isopropyl) organic arsenicals (e.g., DSMA, and MSMA), 7,8-dihydropteroate synthase inhibitors, chloroplast isoprenoid synthesis inhibitors and cell-wall biosynthesis inhibitors. Other herbicides include those herbicides having unknown modes of action or do not fall into a specific category listed in (b1) through (b14) or act through a combination of modes of action listed above. Examples of other herbicides include aclonifen, asulam, amitrole, clomezone, fluometuron, difenzoquat, bromobutide, flurenol, cinmethylin, cumyluron, dazomet, dymron, methyldymron, methiozolon, ipfencarbazone, etobenzanid, fosamine, fosamine-ammonium, metam, oxaziclomefone, oleic acid, pelargonic acid and pyributicarb.

"Herbicide safeners" (b16) are substances added to a herbicide formulation to eliminate or reduce phytotoxic effects of the herbicide to certain crops. These compounds protect crops from injury by herbicides but typically do not prevent the herbicide from controlling undesired vegetation. Examples of herbicide safeners include but are not limited to benoxacor, 1-bromo-4-[(chloromethyl)sulfonyl]benzene, cloquintocet-mexyl, cumyluron, cyometrinil, cyprosulfamide, daimuron, dichlormid, dicyclonon, 4-(dichloroacetyl)-1-oxa-4-azospiro[4.5]decane (MON 4660), 2-(dichloromethyl)-2-methyl-1,3-dioxolane (MG 191), dimepiperate, fenchlorazole-ethyl, fenclorim, flurazole, fluxofenim, furilazole, isoxadifen-ethyl, mefenpyr-diethyl, mephenate, methoxyphenone, naphthalic anhydride and oxabetrinil.

One or more of the following methods and variations as described in Schemes 1-23 can be used to prepare the compounds of Formula 1. The definitions of A, Q, J, R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14} and R^{15} in the compounds of Formulae 1 through 32 below are as defined above in the Summary of the Invention unless otherwise noted. Formulae 1a-1f, 11a-b, 17a, 19a, 21a, 26a, and 27a and are various subsets of a compound of Formulae 1, 11, 17, 19, 21, 26 and 27, respectively. All substituents for Formulae 1a-1f are as defined above for Formula 1 unless otherwise noted.

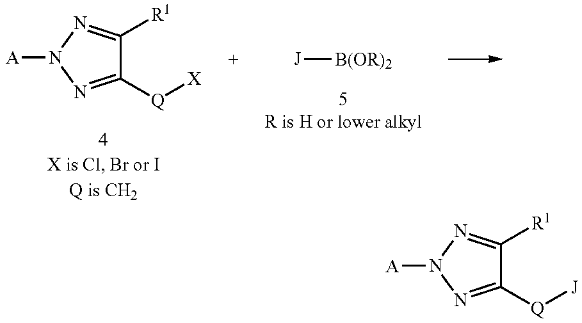
Compounds of Formula 1a, 1b or 1c wherein Q is O, S or NR^6 respectively can be synthesized from compounds of Formula 2 by the reaction shown in Scheme 1 using an electron-deficient aromatic or heteroaromatic compound of Formula 3 wherein X (bound though carbon) is a suitable leaving group, for example, a halogen, sulfonate or alkoxide, in the presence of an appropriate base such as potassium carbonate, cesium carbonate or potassium hydroxide. Typically the reaction is conducted in a polar aprotic solvent such as dimethylsulfoxide, N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidinone or acetonitrile at temperatures ranging from ambient temperature to the reflux temperature of the solvent. Compounds of Formula 3 are commercially available or their preparation is known in the art. For reaction conditions for this general coupling methodology, see Carey, F. A., Sundberg, R. J., *Advanced Organic Chemistry Part B, 4th Edition;* Kluwer Academic/Plenum Publishers, New York, 2001; Chapter 11.2.2 and references cited therein.

Scheme 1



Compounds of Formula 1d wherein Q is CH_2 can be synthesized from a compound of Formula 4 by the reaction shown in Scheme 2. Halomethyl compounds of Formula 4 are reacted with a suitable boronic acid or boronate ester in the presence of a palladium salt or complex such as palladium(II) acetate, tetrakis(triphenylphosphine)palladium(0) or bis(triphenylphosphine)palladium(II) chloride, an appropriate ligand and an inorganic base such as potassium phosphate, potassium carbonate or sodium carbonate. Typically the reaction is conducted in solvent such as 1,2-dimethoxyethane, 1,4-dioxane, toluene, tetrahydrofuran (or a mixture thereof) or t-butanol and water at temperatures ranging from ambient temperature to the reflux temperature of the solvent. Typical procedures using bromomethyl intermediates are disussed in *Eur. J. Chem.* 2011, 46(2), 488-496 and in PCT Patent Publication WO 2012/004714. A typical procedure using a chloromethyl intermediate is discussed in *Angew. Chem., Int. Ed.* 2011, 50(46), 10913-10916. Compounds of Formula 5 are commercially available or their preparation is known in the art.

Scheme 2



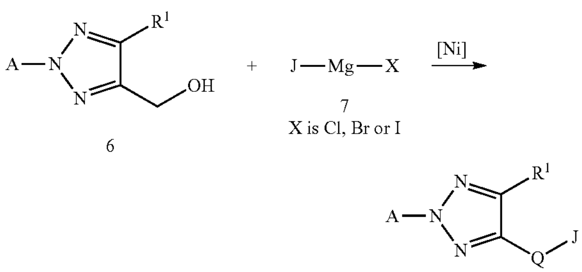
4
X is Cl, Br or I
Q is CH_2

5
R is H or lower alkyl

1d
Q is CH_2

Compounds of Formula 1d can also be synthesized from a compound of Formula 6 by the reaction shown in Scheme 3. Hydroxymethyl derivatives of Formula 6 are reacted with a suitable organomagnesium halide in the presence of a nickel salt or complex such as nickel(II) chloride, nickel(II) bromide, nickel(II) acetoacetate or bis(tricyclohexylphosphine) nickel(II) chloride and an appropriate ligand such as tricyclohexylphosphine, 1,2-bis(diphenylphosphino)ethane or 1,3-bis(2,6-diisopropylphenyl)-1,3-dihydro-2H-imidazol-2-ylidene. Typically the reaction is conducted in a mixture of solvents including but not limited to dibutyl ether, diisopropyl ether and toluene at temperatures ranging from ambient temperature to the reflux temperature of the solvent. For the discovery and optimization of these types of reactions, see D-G. Yu et al. in *J.A.C.S.* 2012, ASAP, available at http://pubs.acs.org/doi/pdf/10.1021/ja307045r. Compounds of Formula 7 are commercially available or their preparation is known in the art.

Scheme 3



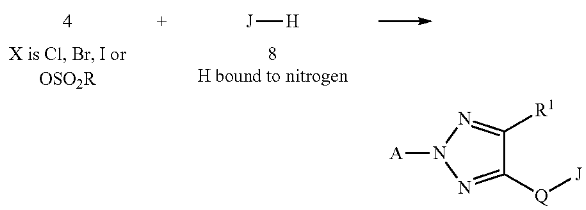
6

7
X is Cl, Br or I

1d
Q is CH_2

Compounds of Formula 1d (wherein Q is CH_2 and J is directly bound to Q through a nitrogen atom) can be synthesized from a compound of Formula 4 by the reaction shown in Scheme 4 wherein X is a suitable leaving group, for example, a halogen or sulfonate, and wherein J is a nitrogen-containing heterocycle. The reaction is typically conducted in the presence of an appropriate base such as potassium carbonate, cesium carbonate or potassium hydroxide. Typically the reaction is conducted in a solvent such as dimethylsulfoxide, N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidinone or acetonitrile at temperatures ranging from ambient temperature to the reflux temperature of the solvent. Compounds of Formula 8 are commercially available or their preparation is known in the art. A typical procedure is discussed in *Nature Chemical Biology* 2008, 4(11), 691-699.

Scheme 4



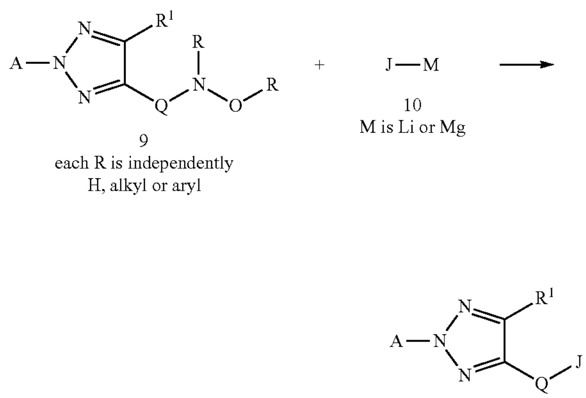
4
X is Cl, Br, I or OSO_2R

8
H bound to nitrogen

1d
Q is CH_2

As shown in Scheme 5, compounds of Formula 1e wherein Q is C(═O) can be synthesized from a compound of Formula 9 and an organolithium or organomagnesium compound of Formula 10. Typically, these reactions are conducted in a solvent mixture containing tetrahydrofuran, diethyl ether or toluene at a temperature ranging from −78° C. to ambient temperature. Compounds of Formula 10 are commercially available or their preparation is known in the art. A typical procedure is disclosed in PCT Patent publication WO 2009/121939.

Scheme 5



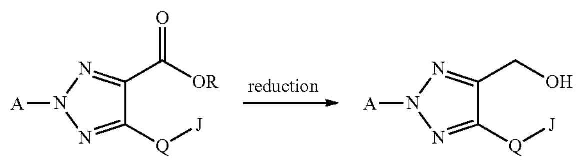
9
each R is independently H, alkyl or aryl

10
M is Li or Mg

1e
Q is C═O

As shown in Scheme 6, a compound of Formula 1f can be prepared from esters of Formula 11 by general methods well known to one skilled in the art. Esters of Formula 11 can be reduced to the corresponding alcohols using a wide variety of reagents, but metal hydride reagents such as lithium aluminum hydride, diisobuyl aluminum hydride or lithium borohydride are particularly general and effective. Typically, these reductions are performed in an ethereal solvent such as diethyl ether, tetrahydrofuran or 1,2-dimethoxyethane at temperatures ranging from −78° C. to the reflux temperature of the solvent. For a comprehensive overview of the methodologies available to reduce esters to alcohols, see Larock, R. C., *Comprehensive Organic Transformations: A Guide to Functional Group* Preparations, *2nd Ed.*, Wiley-VCH, New York, 1999; and references cited therein.

Scheme 6

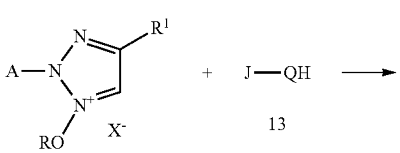


11
R is alkyl

1f

Compounds of Formula 1a, 1b or 1c can alternatively be synthesized by the reaction of N-alkoxy triazolium salts of Formula 12 with a compound of Formula 13 in the presence of a base as shown in Scheme 7. The counterion is typically a non-nucleophilic anion such as tetrafluoroborane or trifluoromethanesufonate. Appropriate solvents for these substitution reactions include acetonitrile, methanol and tetrahydrofuran either alone or mixtures thereof. These reactions are usually conducted at temperatures ranging from 0° C. to the reflux temperature of the solvent. Bases such as potassium carbonate, sodium hydride, sodium carbonate, potassium tert-butoxide, and many others can be employed. The use of an exogenous base is not necessary when anilines are used as the nucleophile. A typical procedure using a phenol is disclosed in UK Patent Application GB 2193493. A typical procedure using a thiophenol is disclosed in *Pest. Sci.* 1996, 48(2), 189-196. A typical procedure using an aniline is disclosed in *J. Chem. Soc., Perkin Transactions* 1 1981, 503-513. Compounds of Formula 13 are commercially available or their preparation is known in the art.

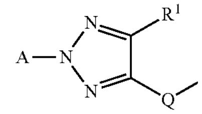
Scheme 7



12
R = lower alkyl

13

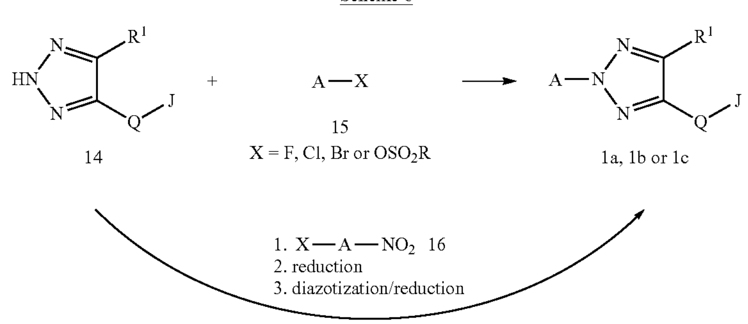
-continued



1a, 1b or 1c

Compounds of Formula 1a, 1b or 1c can also be synthesized from a compound of Formula 14 by the reaction shown in Scheme 8 of an electron-deficient aromatic or heteroaromatic compound of Formula 15 wherein X is a suitable leaving group, for example, a halogen, sulfonyl (such as alkylsulfonyl, trifluoromethanesulfonyl, phenylsulfonyl or p-toluenesulfonyl) or lower alkoxide, in the presence of an appropriate base such as potassium carbonate, cesium carbonate or potassium hydroxide. Typically the reaction is conducted in a solvent such as dimethylsulfoxide, N,N-dimethylformamide, N,N-dimethylacetamide, N-methylpyrrolidinone or acetonitrile at temperatures ranging from ambient temperature to the reflux temperature of the solvent. Compounds of Formula 15 are commercially available or their preparation is known in the art. For reaction conditions for this general coupling methodology, see Carey, F. A.; Sundberg, R. J., *Advanced Organic Chemistry Part B, 4^{th} Edition*; Kluwer Academic/Plenum Publishers, New York, 2001; Chapter 11.2.2 and references cited therein. In cases where a compound of Formula 15 lacks sufficiently electron-withdrawing substituents to enable the aromatic substitution in a practical time frame, a suitable nitro-containing aromatic or heteroaromatic compound of Formula 16 can be used to enhance the reaction rate. It is obvious to one skilled in the art that reduction of the nitro group followed by diazotization/reduction of the resulting aniline will satisfactorily remove the activating nitro group. A typical procedure for this series of steps is disclosed in *Angew. Chem., Int. Ed.* 2010, 49(11), 2018-2022. Compounds of Formulae 15 and 16 are commercially available or their preparation is known in the art.

Scheme 8



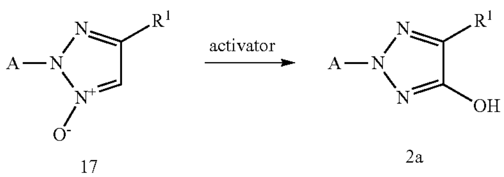
14

15
X = F, Cl, Br or OSO_2R

1a, 1b or 1c

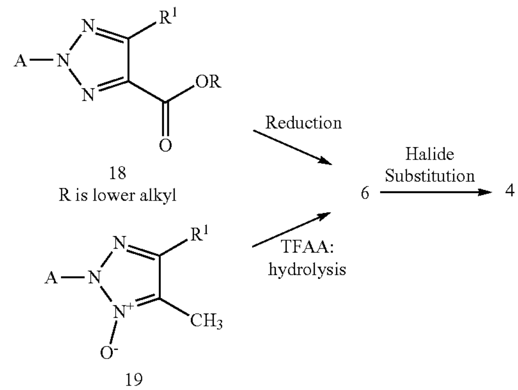
As shown in Scheme 9, a compound of Formula 2a can be synthesized by the reaction of triazole N-oxides of Formula 17 with a suitable activator such as an acid halide, acid anhydride or silyl halide followed by acidic or basic hydrolysis. The activator is selected from acetyl chloride, acetic anhydride (which can also act as the solvent) or trimethylsilyl iodide. Other solvents appropriate for this reaction include chloroform and dichloromethane. These reactions are usually conducted at temperatures ranging from 0° C. to the reflux temperature of the solvent. Basic hydrolysis is typically conducted with a base such as sodium hydroxide, potassium hydroxide or potassium carbonate in a solvent such as water, methanol, ethanol or a mixture tetrahydrofuran and water at temperatures ranging from 0° C. to the reflux temperature of the solvent. Acidic hydrolysis is typically conducted with, but not limited to, an acid such as hydrochloric acid, hydrobromic acid, sulfuric acid, phosphoric acid or acetic acid in a solvent such as chloroform, toluene, methanol, ethanol or water (or a mixture of said solvents) at temperatures ranging from 0° C. to the reflux temperature of the solvent. A typical procedure using acetyl chloride as the activator followed by basic hydrolysis is disclosed in *Bull. Chim. Belg.* 1997, 106(11), 717-728. A typical procedure using trimethylsilyl iodide as the activator followed by acidic hydrolysis is discussed in *Acta Chem. Scan.* 1996, 50(6), 549-555.

Scheme 9



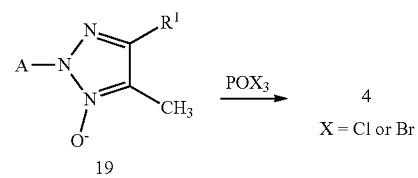
As shown in Scheme 10, a compound of Formula 4 is a particularly useful intermediate for use in the preparation of a compound of Formula 1 and can be prepared from several different precursors. Using reaction conditions similar to those discussed in the method of Scheme 6, esters of Formula 18 can be converted to alcohols of Formula 6. Alcohols of Formula 6 can then be converted to the compounds of Formula 4 using a wide range of reagents such as thionyl chloride, phosphorus trichloride, phosphorus tribromide, triphenylphosphine/bromine, triphenylphosphine/iodine. Alternatively, halogenation methods using hydrohalides in solvents such as acetic acid, acetonitrile, diethyl ether, tetrahydrofuran, dichloromethane, water or a mixture of water with the aforementioned solvents, at temperatures ranging from 0° C. to the reflux temperature of the solvent can be used. Typical procedures for the production of a bromomethyl compound are disclosed in PCT Patent Publication WO 2005/115383. Alternatively, a compound of Formula 6 can be prepared by the reaction of a compound of Formula 19 using trifluoroacetic anhydride as described in *Bull. Soc. Chim. Belg.* 1997, 106(11), 717-727. Alcohols of Formula 6 can subsequently be converted to a compound of Formula 4 by the methods described above for Scheme 10.

Scheme 10



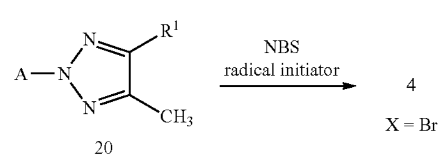
Alternatively, a compound of Formula 4 can be prepared from triazole N-oxides of Formula 19 by the one-step procedure shown in Scheme 11. Reaction of a compound of Formula 19 with halogenating agent such as phosphorus oxybromide or phosphorus oxychloride, in solvents such as 1,4-dioxane, 1,2-dichloroethane, chloroform or toluene, at temperatures ranging from ambient to the reflux temperature of the solvent affords compounds of Formula 4 directly.

Scheme 11



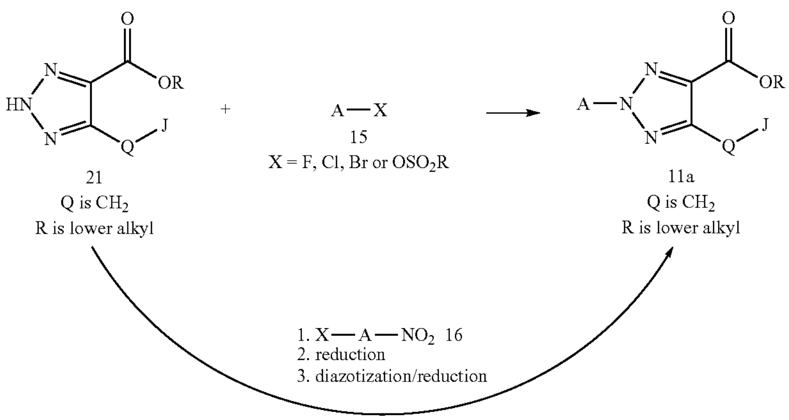
As shown in Scheme 12, bromides of Formula 4 can also be prepared by radical bromination of a compound of Formula 20 using a brominating agent such as N-bromosuccinimide or bromine, a radical initiator such as azobisisobutyronitrile, benzoyl peroxide or a UV light source, in solvents such as carbon tetrachloride or trifluoromethylcyclohexane at temperatures ranging from ambient to the reflux temperature of the solvent. A typical procedure for the synthesis of a bromomethyl compound is disclosed in PCT Patent publication WO 2007/071900.

Scheme 12



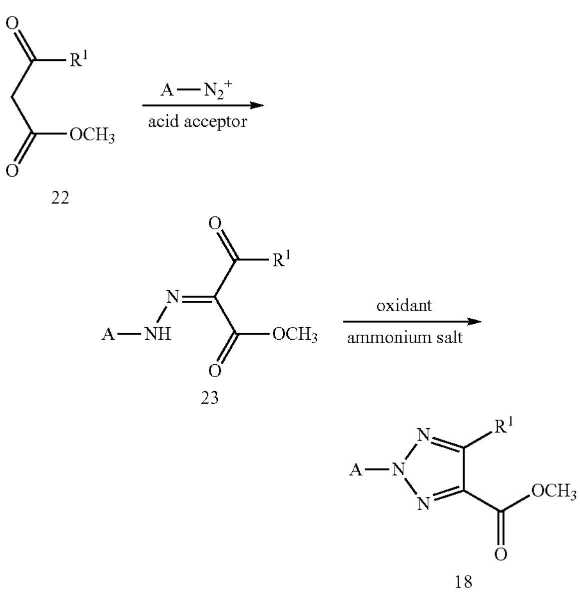
As illustrated in Scheme 13, using reaction conditions similar to those discussed in the method of Scheme 8, triazoles of Formula 21 can be converted into N-aryl triazoles of Formula 11a which are useful for preparing alcohols of Formula 1f as depicted in Scheme 6. Compounds of Formulae 15 (where R is lower alkyl) and 16 are commercially available or their preparation is known in the art.

Scheme 13



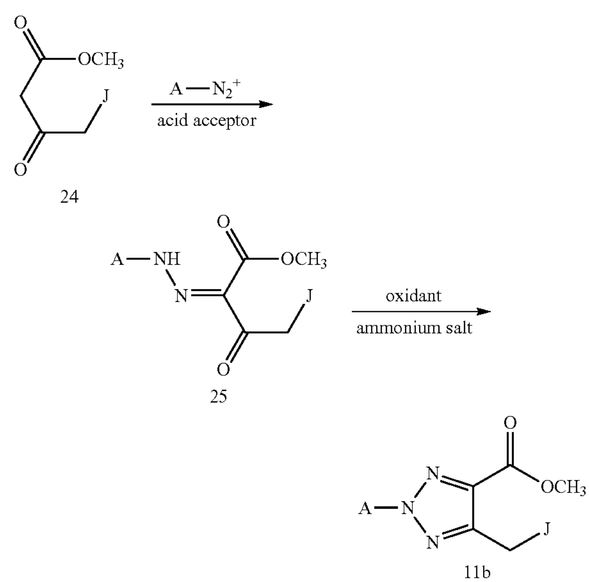
Compounds of Formula 18 can be prepared as shown in Scheme 14. Reaction of a dicarbonyl compound of Formula 22 with a diazonium salt in the presence of an acid acceptor results in a coupling reaction to form a compound of Formula 23. Suitable solvents include lower carboxylic acids such as acetic acid, lower alcohols such as methanol or ethanol, water, and mixtures thereof. Acid acceptors such as, but not limited to, alkali carbonates, bicarbonates, phosphates and acetates can be employed in this reaction. Compounds of Formula 23 can be cyclized to compounds of Formula 18 by reaction with an ammonium salt in the presence of an oxidizing agent. Suitable ammonium salts include halides, acetate, and sulfate among others. The oxidizing agent is preferably, but not limited to, a Cu(II) salt such as copper(II) sulfate, copper(II) chloride or copper(II) bromide or N-iodosuccinimide. Typical conditions for this procedure are described in U.S. Patent Application 20060014785.

Scheme 14



Similarly, Compounds of Formula 11b can be prepared as shown in Scheme 15. The coupling reaction of a dicarbonyl compound of Formula 24 with a diazonium salt in the presence of an acid acceptor can form a compound of Formula 25. Suitable solvents include lower carboxylic acids such as acetic acid, lower alcohols such as methanol or ethanol, water, and mixtures thereof. Acid acceptors such as, but not limited to, alkali carbonates, bicarbonates, phosphates and acetates can be employed in this reaction. Compounds of Formula 25 can be cyclized to compounds of Formula 11b by reaction with an ammonium salt in the presence of an oxidizing agent. Suitable ammonium salts include halides, acetate, and sulfate among others. The oxidizing agent is preferably, but not limited to, a Cu(II) salt such as copper(II) sulfate, copper(II) chloride or copper(II) bromide or N-iodosuccinimide. Typical conditions for this procedure are described in U.S. Patent Application 20060014785.

Scheme 15



As shown in Scheme 16, compounds of Formula 12 can be synthesized by the reaction of triazole N-oxides of Formula 17 with strong alkylating reagents such as trimethyloxonium tetrafluoroborate or methyl trifluoromethanesulfonate. Preferred solvents for this substitution reaction include dichloromethane, chloroform and 1,2-dichloroethane. The reactions are usually conducted at temperatures ranging from 0° C. to the reflux temperature of the solvent. Typical procedures are disclosed in *J. Chem. Soc., Perkin Transactions* 1 1982, 2749-2756 and references cited therein.

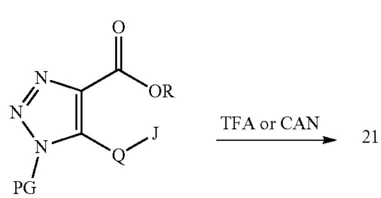
Scheme 16

$$17 \xrightarrow[\text{acid acceptor}]{\text{RX or } R_3OX} 12$$

R = lower alkyl or benzyl

As shown in Scheme 17, a compound of Formula 21 can be obtained by removal of an appropriate protecting group such as a trialkylsilyl group, (i.e. trimethylsilyl), or an optionally substituted benzyl group (i.e. benzyl or p-methoxybenzyl) from compounds of Formula 26. The p-methoxybenzyl group is of particular value as an intermediate to prepare a compound of Formula 1 via a compound of Formula 4 as shown in Scheme 2. Deprotection of a compound of Formula 26 wherein PG is p-methoxybenzyl is typically performed via one of the following two methods. First, acid-catalyzed deprotection is usually conducted in neat trifluoroacetic acid or as a mixture with a solvent such as dichloromethane or 1,2-dichloroethane at temperatures ranging from 0° C. to the reflux temperature of the solvent. A typical procedure is disclosed in PCT Patent publication WO 2005/073192. Second, the p-methoxybenzyl group can be removed using an oxidant such as ceric ammonium nitrate or 2,3-dichloro-5,6-dicyano-1,4-benzoquinone in a mixture of acetonitrile and water or a mixture of dichloromethane and water, respectively. The useful temperature range for these reactions is from ambient to the reflux temperature of the solvent. A typical procedure is disclosed in PCT Patent Publication WO 2007/071900.

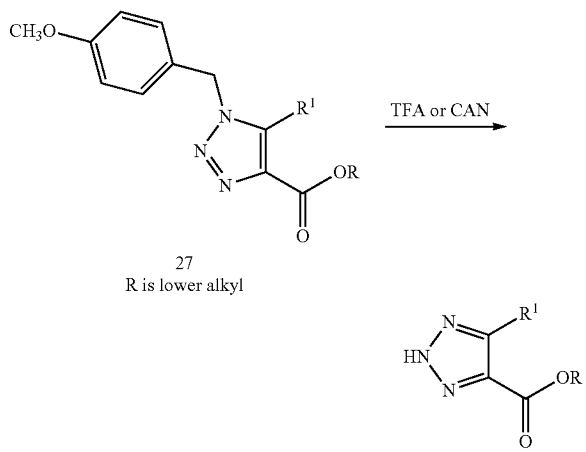
Scheme 17



26
R is lower alkyl
PG is a protection group

As illustrated in Scheme 18, a compound of Formula 23 can be prepared from a compound of Formula 27 using reaction conditions similar to those discussed in the method of Scheme 17. For an exemplary preparation of a compound of Formula 27 wherein R^1 is either a lower alkoxy group or a haloalkoxy group, see PCT Patent Publication WO 2007/096576.

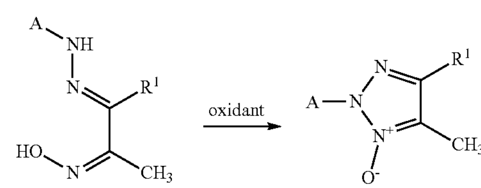
Scheme 18



23
R is lower alkyl

A compound of Formula 19a wherein R^1 can independently be H or C_1-C_4 alkyl can be synthesized by the reaction of a compound of Formula 28 with a suitable oxidant as shown in Scheme 19. Suitable oxidants include a Cu(II) salt, such as copper(II) sulfate, copper(II) chloride or copper(II) bromide, or N-iodosuccinimide. The preferred solvents for the reaction are pyridine, carbon tetrachloride, methanol, ethanol, water and aqueous mixtures of the aforementioned solvents. The reactions are usually conducted at temperatures ranging from 0° C. to the reflux temperature of the solvent. A typical procedure is disclosed in *J. Chem. Soc., Perkin Transactions* 1 1981, 503-513. Compounds of Formula 28 are commercially available or their preparation is known in the art.

Scheme 19

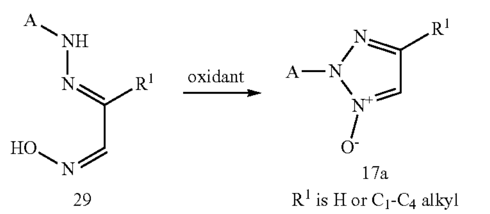


28 — R^1 is H or C_1-C_4 alkyl

19a — R^1 is H or C_1-C_4 alkyl

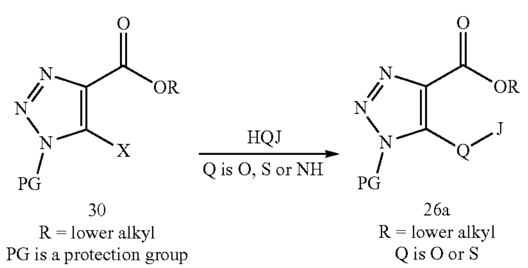
In a similar fashion, a compound of Formula 17a wherein R^1 is H or C_1-C_4 alkyl can be synthesized by the reaction of a compound of Formula 29 with a suitable oxidant as shown in Scheme 20. Suitable oxidants and solvents include those discussed for Scheme 19. The reactions are usually conducted at temperatures ranging from 0° C. to the reflux temperature of the solvent. A typical procedure is disclosed in *J. Chem. Soc., Perkin Transactions* 1 1981, 503-513. Compounds of Formula 29 are commercially available or their preparation is known in the art. A typical procedure is disclosed in *J. Chem. Soc., Perkin Transactions* 1 1981, 503-513.

Scheme 20



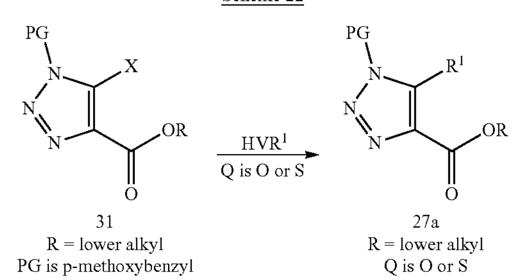
A compound of Formula 26a can be synthesized by the reaction of triazoles of Formula 30 with a wide range of carbon, oxygen, sulfur and nitrogen nucleophiles including cyanide, dialkyl malonates, aryl acetonitriles, aryl acetic acids, aryl acetic esters, amines, phenols, alcohols, thiophenols, alkyl thiols and anilines, optionally in the presence of a base, as shown in Scheme 21. Typical bases including sodium hydride, sodium methoxide, sodium ethoxide, cesium carbonate, potassium carbonate or potassium tert-butoxide can be employed. Solvents suitable for this substitution reaction are dimethylsulfoxide, N,N-dimethylformamide, tetrahydrofuran, lower alkyl alcohols and acetonitrile at temperatures ranging from ambient temperature to the reflux temperature of the solvent. For the preparation of compounds of Formula 30, see *J. Het. Chem.* 1981, 18(6), 1117-1122.

Scheme 21



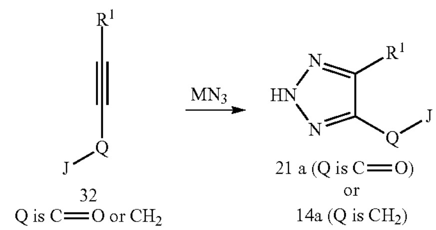
Similarly, a compound of Formula 27a can be synthesized by the reaction of triazoles of Formula 31 with a wide range of carbon, nitrogen, oxygen and sulfur nucleophiles including cyanide, dialkyl malonates, aryl acetonitriles, aryl acetic acids, aryl acetic esters, amines, phenols, alcohols, thiophenols, alkyl thiols and anilines, optionally in the presence of a base, as shown in Scheme 22. Typical bases including sodium hydride, sodium methoxide, sodium ethoxide, cesium carbonate, potassium carbonate or potassium tert-butoxide can be employed. Solvents suitable for this substitution reaction are dimethylsulfoxide, N,N-dimethylformamide, tetrahydrofuran, lower alkyl alcohols and acetonitrile at temperatures ranging from ambient temperature to the reflux temperature of the solvent. For the preparation of compounds of Formula 31, see *J. Het. Chem.* 1981, 18(6), 1117-1122.

Scheme 22



As shown in Scheme 23, a compound of Formulae 21a or 14a wherein Q is C═O or CH_2 respectively can be synthesized by the reaction of compounds of Formula 32 with an inorganic azide salt, typically sodium azide. The preferred solvents for the substitution reaction are dimethylsulfoxide, N,N-dimethylformamide, tetrahydrofuran, lower alkyl alcohols, acetonitrile and water or a mixture thereof at temperatures ranging from 0° C. to the reflux temperature of the solvent. A typical procedure is disclosed in *J. Org. Chem.* 2008, 73(11), 4317-4319. A compound of Formula 32 is commercially available or its preparation is known in the art.

Scheme 23



The synthesis of 1,2,3-triazoles and derivatives thereof are well known in the literature. For a general discussion of their synthesis, see Rachwal, A. R, Katritzky, A. R., 1,2,3-Triazoles, *Comprehensive Heterocyclic Chemistry III* 2008, 5, 1-158 and Tome, A. C., Product class 13: 1,2,3-Triazoles, *Science of Synthesis* 2004, 13, 415-601.

It is recognized by one skilled in the art that various functional groups can be converted into others to provide different compounds of Formula 1. For a valuable resource that illustrates the interconversion of functional groups in a simple and straightforward fashion, see Larock, R. C., *Comprehensive Organic Transformations: A Guide to Functional Group Preparations, 2nd Ed.*, Wiley-VCH, New York, 1999. For example, intermediates for the preparation of compounds of Formula 1 may contain aromatic nitro groups, which can be reduced to amino groups, and then be converted via reactions well known in the art such as the Sandmeyer reaction, to various halides, providing compounds of Formula 1. The above reactions can also in many cases be performed in alternate order

It is recognized that some reagents and reaction conditions described above for preparing compounds of Formula 1 may not be compatible with certain functionalities present in the intermediates. In these instances, the incorporation of protection/deprotection sequences or functional group interconversions into the synthesis will aid in obtaining the desired products. The use and choice of the protecting groups will be apparent to one skilled in chemical synthesis (see, for example, Greene, T. W.; Wuts, P. G. M. *Protective Groups in Organic Synthesis,* 2nd ed.; Wiley: New York, 1991). One skilled in the art will recognize that, in some cases, after the introduction of a given reagent as it is depicted in any individual scheme, it may be necessary to perform additional routine synthetic steps not described in detail to complete the synthesis of compounds of Formula 1. One skilled in the art will also recognize that it may be necessary to perform a combination of the steps illustrated in the above schemes in an order other than that implied by the particular order presented to prepare the compounds of Formula 1.

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Synthesis Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Steps in the following Synthesis Examples illustrate a procedure for each step in an overall synthetic transformation, and the starting material for each step may not have necessarily been prepared by a particular preparative run whose procedure is described in other Examples or Steps. Percentages are by weight except for chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. ^{1}H NMR spectra are reported in ppm downfield from tetramethylsilane in $CDCl_3$ unless otherwise noted; "s" means singlet, "m" means multiplet, "br s" means broad singlet. Mass spectra (MS) are reported as the molecular weight of the highest isotopic abundance parent ion (M+1) formed by addition of H+(molecular weight of 1) to the molecule, observed by mass spectrometry using atmospheric pressure chemical ionization (AP^+) where "amu" stands for atomic mass units. The presence of molecular ions containing one or more higher atomic weight isotopes of lower abundance (e.g., ^{37}Cl, ^{81}Br) is not reported.

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Steps in the following Examples illustrate a procedure for each step in an overall synthetic transformation, and the starting material for each step may not have necessarily been prepared by a particular preparative run whose procedure is described in other Examples or Steps. Percentages are by weight except for chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. ^{1}H NMR spectra are reported in ppm downfield from tetramethylsilane; "s" means singlet, "d" means doublet, "t" means triplet, "q" means quartet, "m" means multiplet and "br s" means broad singlet.

Synthesis Example 1

Preparation of 4-[[5-methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 15)

Step A: Preparation of 4-Methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole 1-oxide

To a stirred solution of anti-pyruvic aldehyde 1-oxime (2.67 g, 30.7 mmol) in diethyl ether (50 mL) was added 4-(trifluoromethyl)phenylhydrazine (5.40 g, 30.7 mmol). The reaction mixture was stirred at 23° C. for 2 h, then concentrated under reduced pressure. The crude residue was dissolved in 15% aqueous pyridine (150 mL). A solution of copper(II) sulfate pentahydrate (15.31 g, 61.3 mmol) in water (75 mL) was added at once. The resulting mixture was stirred at reflux for 17 h, then cooled to 0° C. Ethyl acetate (100 mL) was added and the mixture was filtered through Celite® diatomaceaous filter aid. The layers were separated, and the aqueous layer was extracted with ethyl acetate (2×100 mL). The combined organic layers were washed with 1.0 M aqueous hydrochloric acid (3×50 mL). The organic layer was dried ($MgSO_4$), filtered, and evaporated under reduced pressure. The residue was purified by chromatography on silica gel, eluting with 0 to 50% ethyl acetate in hexanes, to afford the title compound (5.84 g) as a colorless solid.

^{1}H NMR δ 2.37 (s, 3H), 7.32 (s, 1H), 7.75-7.79 (m, 2H), 8.15-8.20 (m, 2H).

Step B: Preparation of 1-Methoxy-4-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazolium tetrafluoroborate (1:1)

To a stirred solution of 4-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole 1-oxide (i.e. the product of Step A, 5.22 g, 21.5 mmol) in dichloromethane (100 mL) was added trimethyloxonium tetrafluoroborate (4.13 g, 27.9 mmol). The reaction mixture was stirred at 23° C. for 65 h, then concentrated under reduced pressure to afford a crude mixture of the title compound as a brown oil which was used directly in the next step without further purification.

^{1}H NMR δ 2.60 (s, 3H), 4.47 (s, 3H), 7.90-7.98 (m, 4H), 9.01 (s, 1H).

Step C: Preparation of 4-methoxy-5-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole

Sodium metal (0.25 g, 11.0 mmol) was stirred at 23° C. in methanol (10 mL) until a clear solution was obtained. This sodium methoxide solution was added to crude 1-methoxy-4-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazolium tetrafluoroborate (1:1) (i.e. the product of Step B, 1.1 g, 3.2 mmol). The reaction mixture was stirred at 23° C. for 6 h, during which time a white precipitate formed. The reaction mixture was diluted with water (20 mL) and extracted with ethyl acetate (40 mL, 10 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure. The crude residue was purified by chromatography on silica gel eluting with 0 to 10% ethyl acetate in hexanes to afford the title compound (0.82 g) as a colorless solid.

^{1}H NMR δ 2.28 (s, 3H), 4.05 (s, 3H), 7.64-7.68 (m, 2H), 7.96-8.00 (m, 2H).

Step D: Preparation of 4-(bromomethyl)-5-methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole

To a solution of 4-methoxy-5-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (i.e. the product of Step C, 0.82 g, 3.2 mmol) in carbon tetrachloride (10 mL) was added N-bromosuccinimide (0.62 g, 3.5 mmol) and 2,2'-azobis(2-methylpropionitrile) (0.026 g, 0.2 mmol). The reaction mixture was heated at reflux for 2 h, then an additional portion of 2,2'-azobis(2-methylpropionitrile) (0.026 g, 0.2 mmol) was added. The reaction mixture was heated at reflux for 2.5 h, cooled to room temperature, diluted with water (10 mL) and extracted with dichloromethane (2×10 mL). The organic layers were dried (Na_2SO_4) and concentrated under reduced pressure to afford a crude material containing approximately 66% (by weight) of the title compound as determined by ^{1}H NMR. The crude material was used directly in the next step without further purification.

^{1}H NMR δ 4.11 (s, 3H), 4.53 (s, 2H), 7.67-7.72 (m, 2H), 8.02-8.07 (m, 2H).

Step E: Preparation of 4-[[5-methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine

To a solution of 4-(bromomethyl)-5-methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (i.e. the product of

Step D, 0.525 g, 66 weight %, 1.0 mmol) in tetrahydrofuran/water (3:1, 4 mL total), was added tetrakis(triphenylphosphine)palladium(0) (0.059 g, 0.05 mmol), potassium phosphate tribasic (0.43 g, 2.0 mmol) and 2-(trifluoromethyl)pyridine-4-boronic acid pinacol ester (0.42 g, 1.5 mmol). The mixture was heated to reflux and stirred for 17 h. The reaction mixture was diluted with water (20 mL) and extracted twice with ethyl acetate (25 mL, 15 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure. The crude residue was purified by chromatography on silica gel eluting with 10% ethyl acetate in hexanes to afford the title compound (0.12 g) as a pale yellow solid.

^{1}H NMR δ 4.06 (s, 3H), 4.09 (s, 2H), 7.42-7.45 (m, 1H), 7.63-7.72 (m, 3H), 8.00-8.04 (m, 2H), 8.64-8.67 (m, 1H).

Synthesis Example 2

Preparation of 4-methoxy-2-[4-(trifluoromethyl)phenyl]-5-[[3-(trifluoromethyl)-1H-pyrazol-1-yl]methyl]-2H-1,2,3-triazole (Compound 17)

Step A: Preparation of 4-methoxy-2-[4-(trifluoromethyl)phenyl]-5-[[3-(trifluoromethyl)-1H-pyrazol-1-yl]methyl]-2H-1,2,3-triazole

To a solution of 4-(bromomethyl)-5-methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (i.e. the product of Example 1, Step D) (0.25 g, 66 weight %, 0.5 mmol) in N,N-dimethylformamide (2 mL total), was added 3-(trifluoromethyl)pyrazole (0.082 g, 0.6 mmol) and anhydrous potassium carbonate (0.21 g, 1.5 mmol). The mixture was heated to 55° C. and stirred for 75 min. The reaction mixture was cooled to 23° C., diluted with water (20 mL) and extracted with ethyl acetate (15 mL). The organic layer was washed with water (10 mL) and saturated aqueous sodium chloride solution (10 mL), dried ($MgSO_4$) and concentrated under reduced pressure. The crude residue was purified by chromatography on silica gel eluting with 0 to 40% ethyl acetate in hexanes to afford the title compound (0.098 g) as a colorless oil.

^{1}H NMR δ 4.07 (s, 3H), 5.44 (s, 2H), 6.53-6.55 (m, 1H), 7.55-7.59 (m, 1H), 7.67-7.72 (m, 2H), 8.02-8.07 (m, 2H).

Synthesis Example 3

Preparation of 4-methyl-2-[4-(trifluoromethyl)phenyl]-5-[[5-(trifluoromethyl)-3-thienyl]oxy]-2H-1,2,3-triazole (Compound 1)

Step A: Preparation of 4-methyl-2-[4-(trifluoromethyl)phenyl]-5-[[5-(trifluoromethyl)-3-thienyl]oxy]-2H-1,2,3-triazole

Potassium tert-butoxide (0.30 g, 2.6 mmol) and 5-trifluoromethylthiophene-3-one (0.44 g, 2.6 mmol) were dissolved in acetonitrile (4 mL). A solution of crude 1-methoxy-4-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazolium tetrafluoroborate (1:1) (i.e., the product of Example 1, Step B, 0.70 g, 2.0 mmol) in acetonitrile (4 mL) was added at once. The reaction mixture was stirred at 23° C. for 27 h. The reaction mixture was diluted with water (20 mL) and extracted with diethyl ether (2×25 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure. The crude residue was purified by chromatography on silica gel eluting with 0 to 5% ethyl acetate in hexanes to afford the title compound (0.105 g) as a colorless solid.

^{1}H NMR δ 2.37 (s, 3H), 7.35-7.37 (m, 1H), 7.41-7.43 (m, 1H), 7.67-7.73 (m, 2H), 8.02-8.06 (m, 2H).

Synthesis Example 4

Preparation of 4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]oxy]-2-(trifluoromethyl)pyridine (Compound 129)

Step A: Preparation of 2-(4-fluorophenyl)-4-methyl-2H-1,2,3-triazole 1-oxide

To a stirred solution of anti-pyruvic aldehyde 1-oxime (3.4 g, 39 mmol) in diethyl ether (75 mL) was added 4-fluorophenylhydrazine hydrochloride (5.85 g, 36 mmol). The reaction mixture was stirred at 23° C. for 16 h, and then concentrated under reduced pressure. The crude residue was dissolved in pyridine (120 mL). A solution of copper(II) sulfate pentahydrate (18 g, 72 mmol) in water (55 mL) was added dropwise over 4 min. The resulting mixture was stirred at reflux for 2 h. The mixture was concentrated under reduced pressure to remove excess pyridine. To the mixture was added 1.0 M aqueous hydrochloric acid. The mixture was extracted with ethyl acetate and the organic layer was separated and washed with 1.0 M aqueous hydrochloric acid until a clear amber organic layer was obtained. The organic layer was dried ($MgSO_4$), filtered, and evaporated under reduced pressure to afford the title compound (6.6 g) as a colorless solid. The title compound was used directly in the next step without further purification.

^{1}H NMR δ 2.35 (s, 3H), 7.17-7.22 (m, 2H), 7.29 (s, 1H), 7.86-7.91 (m, 2H).

Step B: Preparation of 2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl acetate

2-(4-Fluorophenyl)-4-methyl-2H-1,2,3-triazole 1-oxide (i.e. the product of Step A, 6.6 g, 34 mmol) was added to acetic anhydride (47 mL, 500 mmol), and the reaction mixture was stirred at reflux for 28 h. The reaction was concentrated under reduced pressure. The residue was taken up in ethyl acetate, washed successively with water and saturated aqueous sodium chloride solution, dried with magnesium sulfate and concentrated under reduced pressure to afford the title compound (7.8 g) as a beige solid. The title compound was used directly in the next step without further purification.

^{1}H NMR δ 2.26 (s, 3H), 2.38 (s, 3H), 7.10-7.16 (m, 2H), 7.88-7.94 (m, 2H).

Step C: Preparation of 2-(4-fluorophenyl)-2,3-dihydro-5-methyl-4H-1,2,3-triazol-4-one

2-(4-Fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl acetate (i.e. the product of Step B, 7.8 g, 33 mmol) was suspended in methanol (150 mL). A solution of sodium hydroxide (7 M, 22 mL, 140 mmol) was added over several minutes with stirring during which time the mixture became homogeneous and then stirred at 23° C. for 18 h. The reaction was concentrated under reduced pressure to remove excess methanol. The remaining residue was diluted with water (200 mL) and washed with hexanes. The aqueous layer was acidified with concentrated hydrochloric acid during which time a thick creamy precipitate formed. The mixture was diluted with water and stirred for 30 min. The precipitate was filtered and washed well with water. The moist solid was dissolved in ethyl acetate, dried ($MgSO_4$) and concentrated under reduced pressure to afford the title compound (6.1 g) as a beige solid. The title compound was used directly in the next step without further purification.

^1H NMR δ 2.33 (s, 3H), 7.12-7.19 (m, 2H), 7.73-7.80 (m, 2H), 9.73 (s, 1H).

Step D: Preparation of 4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]oxy]-2-(trifluoromethyl)pyridine

To a solution of 2-(4-fluorophenyl)-2,3-dihydro-5-methyl-4H-1,2,3-triazol-4-one (i.e. the product of Step C, 3.1 g, 16 mmol) in N,N-dimethylformamide (70 mL) was added anhydrous potassium carbonate (6.2 g, 45 mmol) under an atmosphere of nitrogen. 4-Chloro-2-trifluoromethyl-pyridine (2.9 g, 16 mmol) was added and the mixture was heated to 100° C. for 20 h. The reaction mixture was diluted with water, then extracted with diethyl ether. The organic layer was washed successively with water and saturated aqueous sodium chloride solution, dried ($MgSO_4$), filtered, and concentrated under reduced pressure. The crude material was purified by chromatography on silica gel eluting with 0 to 20% ethyl acetate in hexanes to obtain the title compound (4.2 g) as a viscous light yellow oil that solidified upon standing to form an off-white solid.

^1H NMR δ 2.32 (s, 3H), 7.14-7.19 (m, 2H). 7.28-7.32 (m, 1H), 7.50-7.54 (m, 1H), 7.90-7.96 (m, 2H), 8.65-8.69 (m, 1H).

Synthesis Example 5

Preparation of 5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole-4-methanol (Compound 114)

Step A: Preparation of 1-(azidomethyl)-4-methoxybenzene

To a stirred solution of 4-methoxybenzyl chloride (25.0 g, 156 mmol) in N,N-dimethylformamide (75 mL) was added sodium azide (11.5 g, 177 mmol). The reaction mixture was stirred at 23° C. for 15 h, then diluted with water (300 mL). The mixture was extracted with diethyl ether (3×75 mL) and the combined organic layers were washed with water (2×100 mL). The organic layer was dried ($MgSO_4$), filtered, and evaporated under reduced pressure to afford the title compound (25.5 g) as a pale yellow oil. The title compound was used directly in the next step without further purification.

^1H NMR δ 3.82 (s, 3H), 4.27 (s, 2H), 6.88-6.93 (m, 2H), 7.22-7.27 (m, 2H).

Step B: Preparation of ethyl 5-hydroxy-1-[(4-methoxyphenyl)methyl]-1H-1,2,3-triazole-4-carboxylate

Sodium metal (3.8 g, 164 mmol) was added to absolute ethanol (200 mL). The mixture was stirred under reflux until a clear solution was obtained. Diethyl malonate (26.3 g, 164 mmol) was added to this solution which was again heated to reflux, and a solution of 1-(azidomethyl)-4-methoxybenzene (i.e. the product of Step A, 25.5 g, 156 mmol) in ethanol (50 mL) was added at once. The reaction mixture was stirred at reflux for 24 h then the reaction mixture was concentrated to dryness under reduced pressure. The residue was diluted with water (100 mL) and acidified to pH 2 with 1 M aqueous hydrochloric acid, stirred for 30 min, and the solid was filtered off and washed with water. The solid was dried over phosphorus pentoxide. The solid was stirred in chloroform (500 mL) and the insoluble solids were filtered off. Hexanes (400 mL) were added to precipitate the product, which was removed by filtration and dried to afford the title compound (12.0 g) as a beige solid.

^1H NMR δ 1.35-1.40 (m, 3H), 3.78 (s, 3H), 4.36-4.43 (m, 2H), 5.30 (s, 2H), 6.15 (br s, 1H) 6.83-6.88 (m, 2H), 7.27-7.32 (m, 2H).

Step C: Preparation of ethyl 5-chloro-1-[(4-methoxyphenyl)methyl]-1H-1,2,3-triazole-4-carboxylate

Ethyl 5-hydroxy-1-[(4-methoxyphenyl)methyl]-1H-1,2,3-triazole-4-carboxylate (i.e. the product of Step B, 10.0 g, 36.1 mmol) was suspended in anhydrous toluene (300 mL) under a nitrogen atmosphere. Phosphorus pentachloride (8.3 g, 39.8 mmol) was added and the mixture was stirred at 40° C. for 90 min. during which time a clear yellow solution was formed. The reaction was concentrated under reduced pressure to remove most of the toluene. The resulting residue was diluted with diethyl ether (150 mL) and washed with saturated aqueous sodium bicarbonate solution (70 mL) and water (70 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product which was recrystallized twice from hexanes (200 mL, 100 mL) to afford the title compound (6.0 g) as a pale yellow solid.

^1H NMR δ 1.38-1.43 (m, 3H), 3.79 (s, 3H), 4.40-4.46 (m, 2H), 5.50 (s, 2H), 6.85-6.89 (m, 2H), 7.24-7.29 (m, 2H).

Step D: Preparation of ethyl-1-[(4-methoxyphenyl)methyl]-5-[(3-(trifluoromethoxy)phenoxy]-1H-1,2,3-triazole-4-carboxylate

To a solution of 3-(trifluoromethoxy)phenol (0.99 g, 5.6 mmol) in N,N-dimethylformamide (10 mL) was added sodium hydride (0.23 g, 5.8 mmol, 60% dispersion in oil). The mixture was stirred at 23° C. for 45 min. then ethyl 5-chloro-1-[(4-methoxyphenyl)methyl]-1H-1,2,3-triazole-4-carboxylate (i.e. the product of Step C, 1.50 g, 5.1 mmol) was added. The reaction mixture was heated to 75° C. for 90 h. Additional sodium hydride (0.06 g, 1.5 mmol) and 3-(trifluoromethoxy)phenol (0.25 g, 1.4 mmol) were added and the mixture was stirred at 75° C. for 45 h. The reaction mixture was concentrated to dryness under reduced pressure. The resulting residue was taken up in ethyl acetate (50 mL) and washed successively with water (2×50 mL) and saturated aqueous sodium chloride solution (50 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product. The crude material was purified by chromatography on silica gel eluting with 0 to 60% ethyl acetate in hexanes to obtain the title compound (1.52 g) as a yellow oil.

^1H NMR δ 1.07-1.11 (m, 3H), 3.74 (s, 3H), 4.15-4.21 (m, 2H), 5.38 (s, 2H), 6.60-6.65 (m, 2H), 6.73-6.78 (m, 2H), 6.94-6.99 (m, 1H), 7.15-7.20 (m, 2H), 7.22-7.26 (m, 1H).

Step E: Preparation of ethyl 5-[3-(trifluoromethoxy)phenoxy]-2H-1,2,3-triazole-4-carboxylate

A solution of ethyl-1-[(4-methoxyphenyl)methyl]-5-[(3-(trifluoromethoxy)phenoxy]-1H-1,2,3-triazole-4-carboxylate (i.e. the product of Step D, 1.50 g, 3.4 mmol) in trifluoroacetic acid (35 mL) was heated to 65° C. with stirring for 5 h. The reaction mixture was concentrated to dryness under reduced pressure. The residue was taken up in ethyl acetate (50 mL) and washed with saturated aqueous sodium bicarbonate solution (30 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product. The crude material was purified by chromatography on silica gel eluting with 0 to 40% ethyl acetate in 1-chlorobutane to obtain the title compound (0.90 g) as a beige solid.

^{1}H NMR δ 1.28-1.32 (m, 3H), 4.36-4.42 (m, 2H), 7.02-7.12 (m, 3H), 7.35-7.40 (m, 1H), 12.62 (br s, 1H).

Step F: Preparation of ethyl 2-[2-nitro-4-(trifluoromethyl)phenyl]-5-[3-(trifluoromethoxy)phenoxy]-2H-1,2,3-triazole-4-carboxylate

To a solution of ethyl 5-[3-(trifluoromethoxy)phenoxy]-2H-1,2,3-triazole-4-carboxylate (i.e. the product of Step E, 0.55 g, 1.7 mmol) in N,N-dimethylformamide (5 mL) was added anhydrous potassium carbonate (0.48 g, 3.5 mmol) and 4-fluoro-3-nitrobenzotrifluoride (0.29 mL, 2.1 mmol). The mixture was heated to 80° C. with stirring for 90 min. The reaction mixture was concentrated to dryness under reduced pressure. The resulting residue was diluted with water (10 mL) and extracted with ethyl acetate (30 mL, 15 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product. The crude material was purified by chromatography on silica gel eluting with 0 to 20% ethyl acetate in hexanes to obtain the title compound (0.76 g) as a pale yellow oil.

^{1}H NMR δ 1.36-1.41 (m, 3H), 4.42-4.48 (m, 2H), 7.07-7.21 (m, 3H), 7.41-7.45 (m, 1H), 7.96-7.99 (m, 1H), 8.10-8.14 (m, 1H).

Step G: Preparation of 2-(2-amino-4-trifluoromethyl-phenyl)-5-(3-trifluoromethoxy-phenoxy)-2H-[1,2,3]triazole-4-carboxylic acid ethyl ester

To a solution of ethyl 2-[2-nitro-4-(trifluoromethyl)phenyl]-5-[3-(trifluoromethoxy)phenoxy]-2H-1,2,3-triazole-4-carboxylate (i.e. the product of Step F, 0.76 g, 1.5 mmol) in acetonitrile (30 mL) was added a solution of sodium hydrosulfite (1.31 g, 7.5 mmol) in water (20 mL). The mixture was stirred at 23° C. for 2.5 h. The reaction mixture was diluted with saturated aqueous sodium chloride solution (30 mL) and extracted with ethyl acetate (2×50 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the title compound (0.70 g) as a pale yellow solid. The title compound was used directly in the next step without further purification.

^{1}H NMR δ 1.31-1.36 (m, 3H), 4.38-4.44 (m, 2H), 7.00-7.18 (m, 5H), 7.39-7.44 (m, 1H), 7.98-8.01 (m, 1H).

Step H: Preparation of ethyl 5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole-4-carboxylate

To a solution of ethyl 2-[2-amino-4-(trifluoromethyl)phenyl]-5-[3-(trifluoromethoxy)phenoxy]-2H-1,2,3-triazole-4-carboxylate (i.e. the product of Step G, 0.70 g, 1.5 mmol) in ethanol (20 mL) was added concentrated sulfuric acid (2 mL). The stirring mixture was cooled to −20° C., and then isopentyl nitrite (0.91 g, 8.8 mmol) was added dropwise over 5 min. The reaction mixture was stirred at −20° C. for 1 h, after which an aqueous solution of hypophosphorus acid (3.9 g, 29.4 mmol, 50% in water) was added. The solution was stirred at 23° C. for 14 h. The reaction mixture was diluted with saturated aqueous sodium chloride solution (20 mL), extracted with ethyl acetate (2×40 mL), and washed with saturated aqueous sodium bicarbonate solution (2×20 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude residue which was purified by chromatography on silica gel eluting with 0 to 15% ethyl acetate in hexanes to obtain the title compound (0.55 g) as a colorless solid.

^{1}H NMR δ 1.33-1.38 (m, 3H), 4.40-4.46 (m, 2H), 7.07-7.12 (m, 1H), 7.17-7.21 (m, 2H), 7.39-7.44 (m, 1H), 7.73-7.78 (m, 2H), 8.15-8.19 (m, 2H).

Step I: Preparation of 5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole-4-methanol

To a solution of ethyl 5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole-4-carboxylate (i.e. the product of Step H, 0.39 g, 0.8 mmol) in anhydrous tetrahydrofuran (6 mL) that was cooled to 0° C. was added a solution of lithium aluminum hydride in tetrahydrofuran (1.0 M, 0.8 mL, 0.8 mmol). The reaction mixture was stirred at 0° C. for 20 min., after which the reaction was quenched with the addition of ethyl acetate (5 mL). The mixture was stirred at 23° C. for 5 min., and then water (6 drops) was added. The mixture was stirred for 5 min., and then sodium sulfate was added. The mixture was stirred for 5 min., and then the mixture was filtered and concentrated under reduced pressure to obtain the title compound (0.35 g, 100%) as a pale yellow oil. The title compound was used directly in the next step without further purification.

^{1}H NMR δ 1.90-1.95 (m, 1H), 4.80-4.84 (m, 2H), 7.05-7.09 (m, 1H), 7.18-7.23 (m, 2H), 7.38-7.44 (m, 1H), 7.70-7.74 (m, 2H), 8.05-8.09 (m, 2H).

Synthesis Example 6

Preparation of 4-methyl-5-[3-(trifluoromethoxy)phenoxy]-2-[(4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (Compound 119)

Step A: Preparation of 4-(Bromomethyl)-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl)-2H-1,2,3-triazole

5-[3-(Trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole-4-methanol (i.e. the product of Example 5, Step I, 0.17 g, 0.4 mmol) was suspended in 33% hydrobromic acid in acetic acid (2 mL) and 48% hydrobromic acid in water (2 mL). The mixture was heated to reflux with stirring for 4 h. The reaction mixture was cooled to 0° C. and basified with 50% aqueous sodium hydroxide solution. The reaction mixture was diluted with water (20 mL), extracted with ethyl acetate (3×15 mL), and washed with saturated aqueous sodium bicarbonate solution (10 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to obtain the title compound (0.19 g) as a pale yellow solid. The title compound was used directly in the next step without further purification.

^{1}H NMR δ 4.56 (s, 2H), 7.07-7.11 (m, 1H), 7.22-7.26 (m, 2H), 7.40-7.45 (m, 1H), 7.70-7.74 (m, 2H), 8.04-8.08 (m, 2H).

Step B: Preparation of 4-methyl-5-[3-(trifluoromethoxy)phenoxy]-2-[(4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole

A reaction vial was charged with a magnetic stir bar, 4-(bromomethyl)-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl)-2H-1,2,3-triazole (i.e. the product of Step A, 0.075 g, 0.16 mmol) and palladium on carbon (5 weight %, 0.033 g, 0.03 mmol). The vial was purged with nitrogen gas, and then absolute ethanol (5 mL) was added. The vial was purged and backfilled with hydrogen gas 10 times. The solution was stirred at 23° C. for 6 h under a balloon of hydrogen gas. The reaction mixture was quenched with triethylamine (0.1 mL), stirred for 5 min., filtered, and concentrated under reduced pressure. The residue was diluted with water (5 mL) and extracted with ethyl acetate (2×5 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to obtain the title compound (0.046 g,) as a beige solid.

^{1}H NMR δ 2.32 (s, 3H), 7.02-7.06 (m, 1H), 7.12-7.17 (m, 2H), 7.37-7.42 (m, 1H), 7.68-7.73 (m, 2H), 8.02-8.07 (m, 2H).

Synthesis Example 7

Preparation of 4-(methoxymethyl)-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (Compound 115)

Step A: Preparation of 4-(methoxymethyl)-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole

To a stirred solution of 5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole-4-methanol (i.e. the product of Example 5, Step I, 0.075 g, 0.18 mmol) in anhydrous tetrahydrofuran (2 mL) was added sodium hydride (0.011 g, 0.28 mmol, 60% dispersion in oil). After 15 min., iodomethane (0.017 mL, 0.27 mmol) was added. The mixture was stirred at 23° C. for 1.75 h. The reaction mixture was diluted with water (20 mL), extracted with diethyl ether (3×15 mL), and washed with saturated aqueous sodium chloride solution (10 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product which was purified by chromatography on silica gel eluting with 0 to 10% ethyl acetate in hexanes to obtain the title compound (0.045 g.) as a clear, colorless oil.

^{1}H NMR δ 3.43 (s, 3H), 4.56 (s, 3H), 7.04-7.08 (m, 1H), 7.17-7.22 (m, 2H), 7.38-7.43 (m, 1H), 7.69-7.74 (m, 2H), 8.06-8.11 (m, 2H).

Synthesis Example 8

Preparation of 4-(fluoromethyl)-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (Compound 116)

Step A: Preparation of 4-(fluoromethyl)-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole

To a stirred solution of 5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole-4-methanol (i.e. the product of Example 5, Step I, 0.075 g, 0.18 mmol) in anhydrous dichloromethane (4 mL) cooled to −78° C. was added (diethylamino)sulfur trifluoride (0.032 mL, 0.24 mmol). The mixture was stirred for 2 h during which time the temperature increase to −30° C. The reaction mixture was diluted with saturated aqueous sodium bicarbonate solution (5 mL), extracted with ethyl acetate (3×15 mL), and washed with saturated aqueous sodium chloride solution (10 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product which was purified by chromatography on silica gel eluting with 0 to 10% ethyl acetate in hexanes to obtain the title compound (0.052 g) as a yellow solid.

^{1}H NMR δ 5.44-5.46 (m, 2H), 7.07-7.11 (m, 1H), 7.21-7.25 (m, 2H), 7.40-7.45 (m, 1H), 7.71-7.76 (m, 2H), 8.07-8.12 (m, 2H).

Synthesis Example 9

Preparation of 4-ethyl-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (Compound 125)

Step A: Preparation of 4-ethyl-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole

To a suspension of copper(I) cyanide (0.037 g, 0.41 mmol) in anhydrous tetrahydrofuran (2 mL) at −78° C. under a nitrogen atmosphere was added a solution of methyllithium in diethyl ether (1.6 M, 0.54 mL, 0.86 mmol). The mixture was stirred at 0° C. until a clear, colorless solution formed, and then the solution was cooled back to −78° C. To the methylcuprate solution was added a solution of 4-(bromomethyl)-5-[3-(trifluoromethoxy)phenoxy]-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazole (i.e. the product of Example 6, Step A, 0.100 g, 0.21 mmol) in anhydrous tetrahydrofuran (4 mL). The mixture was stirred for 1 h. The reaction mixture was quenched with saturated aqueous ammonium chloride solution (5 mL) and stirred vigorously at 23° C. until the solution turned deep blue in color. The reaction mixture was extracted with ethyl acetate (2×10 mL). The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product which was purified by chromatography on silica gel eluting with 0 to 10% ethyl acetate in hexanes to obtain the title compound (0.038 g) as a clear, colorless oil.

^{1}H NMR δ 1.29-1.35 (m, 3H), 2.68-2.75 (m, 2H), 7.01-7.06 (m, 1H), 7.11-7.17 (m, 2H), 7.36-7.42 (m, 1H), 7.68-7.72 (m, 2H), 8.03-8.07 (m, 2H).

Synthesis Example 10

Preparation of 4-[[2-(2,4-difluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 54)

Step A: Preparation of 2-(2,4-difluorophenyl)-4,5-dimethyl-2H-1,2,3-triazole 1-oxide

To a stirred solution of anti-pyruvic aldehyde 1-oxime (2.2 g, 22.2 mmol) in diethyl ether (50 mL) was added 2,4-difluorophenylhydrazine hydrochloride (4.0 g, 22.2 mmol) and pyridine (2 mL). The reaction mixture was stirred at 23° C. for 64 h. The solid that formed was removed by filtration and washed with diethyl ether. The filtrate was concentrated under reduced pressure. The crude residue was dissolved in pyridine (100 mL). A solution of copper(II) sulfate pentahydrate (11.1 g, 44.4 mmol) in water (60 mL) was added at once and the resulting mixture was stirred at reflux for 20 h. The mixture was diluted with water and extracted with diethyl ether. The combined organic layers were washed with 1.0 M aqueous hydrochloric acid, dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product. The crude material was purified by chromatography on silica gel eluting with 0 to 100% ethyl acetate in hexanes to obtain the title compound (1.98 g) as an orange solid.

^{1}H NMR δ 2.26 (s, 3H), 2.33 (s, 3H), 7.01-7.07 (m, 2H), 7.48-7.54 (m, 1H).

Step B: Preparation of [2-(2,4-difluoro-phenyl)-5-methyl-2H-[1,2,3]triazol-4-yl]-methanol

To a solution of 2-(2,4-difluorophenyl)-4,5-dimethyl-2H-1,2,3-triazole 1-oxide (i.e. the product of Step A, 1.78 g, 7.0 mmol) in tetrahydrofuran (14 mL) was added trifluoroacetic anhydride (2.5 mL, 17.5 mmol). The reaction mixture was stirred at 110° C. in the microwave for 75 min. The mixture was diluted with ethyl acetate, washed successively with 1.0 M aqueous sodium hydroxide and 50% aqueous sodium hydroxide, dried ($MgSO_4$) and concentrated under reduced pressure to afford the crude product. The crude material was purified by chromatography on silica gel eluting with 0 to 100% ethyl acetate in hexanes to obtain the title compound (0.59 g) as a colorless solid.

^{1}H NMR δ 1.79 (br s, 1H), 2.43 (s, 3H), 4.82 (s, 2H), 6.96-7.05 (m, 2H), 7.70-7.76 (m, 1H).

Step C: Preparation of 4-(bromomethyl)-2-(2,4-difluorophenyl)-5-methyl-2H-1,2,3-triazole

2-(2,4-Difluorophenyl)-5-methyl-2H-1,2,3-triazole-4-methanol (i.e. the product of Step B, 0.70 g, 3.1 mmol) was suspended in 48% hydrobromic acid in water (16 mL). The mixture was heated to reflux with stirring for 2 h. The reaction mixture was diluted with water, cooled to 0° C. and basified with 50% aqueous sodium hydroxide solution. The reaction mixture was extracted with ethyl acetate, dried ($MgSO_4$) and concentrated under reduced pressure to obtain the title compound (0.75 g) as a pale yellow oil. The title compound was used directly in the next step without further purification.

^{1}H NMR δ 2.43 (s, 3H), 4.58 (s, 2H), 6.96-7.05 (m, 2H), 7.72-7.78 (m, 1H).

Step D: Preparation of 4-[[2-(2,4-difluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine

To a solution of 4-(bromomethyl)-2-(2,4-difluorophenyl)-5-methyl-2H-1,2,3-triazole (i.e. the product of Step C, 0.30 g, 1.0 mmol) in tetrahydrofuran/water (3:1, 4 mL total), was added tetrakis(triphenylphosphine)palladium(0) (0.058 g, 0.05 mmol), potassium phosphate tribasic (0.43 g, 2.0 mmol) and 2-(trifluoromethyl)pyridine-4-boronic acid pinacol ester (0.31 g, 1.15 mmol). The mixture was heated to 70° C. and stirred for 96 h. The reaction mixture was diluted with water and extracted with ethyl acetate. The organic layer was dried ($MgSO_4$) and concentrated under reduced pressure. The crude residue was purified by twice by chromatography on silica gel eluting with 0 to 100% ethyl acetate in hexanes, and then was purified by reverse-phase chromatography on C18 silica gel to afford the title compound (0.18 g) as a colorless solid.

^{1}H NMR δ 2.30 (s, 3H), 4.17 (s, 2H), 6.97-7.06 (m, 2H), 7.37-7.41 (m, 1H), 7.60-7.63 (m, 1H), 7.72-7.78 (m, 1H), 8.64-8.68 (m, 1H).

Synthesis Example 11

Preparation of 4-[[5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine (Compound 196)

Step A: Preparation of ethyl 5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazole-4-carboxylate

A stirred mixture of 4-fluoroaniline (11.1 g, 100 mmol) in water (50 mL) and concentrated hydrochloric acid (19 mL) was cooled to −15° C. To this mixture was added a previously cooled (0° C.) solution of sodium nitrite (7.6 g, 110 mmol) in water (25 mL) over 5 min. Ice was added directly to the reaction to maintain the temperature below 5° C. After the addition was complete, the reaction was stirred at 0° C. for 15 min. Sodium acetate (41.0 g, 500 mmol) was added followed by ethyl 3-ethoxy-3-iminopropionate (15.9 g, 100 mmol). A yellow precipitate formed immediately. The suspension was stirred at 23° C. for 30 min., and then the solid was filtered and washed with water (40 mL). The still wet hydrazone was dissolved in pyridine (150 mL). A solution of copper (II) sulfate (49.7 g, 199 mmol) in water (150 mL) was added at once. The dark mixture was heated to 90° C. for 4 h. The majority of the pyridine (~100 mL) was removed under vacuum. The residue was diluted with ethyl acetate (200 mL), water (100 mL) and 2 M sulfuric acid (80 mL). The resulting emulsion was filtered through Celite® diatomaceous earth filter aid. The organic layer was washed with 2 M sulfuric acid (2×100 mL), dried ($MgSO_4$) and concentrated under reduced pressure. The resulting crude mixture was recrystallized from ethanol (80 mL) to obtain the title compound (15.1 g) as a pale red solid.

^{1}H NMR δ 1.40-1.45 (m, 3H), 1.49-1.54 (m, 3H), 4.41-4.51 (m, 4H), 7.13-7.18 (m, 2H), 7.99-8.04 (m, 2H).

Step B: Preparation of 5-ethoxy-2-(4-fluorophenyl)-N-methoxy-N-methyl-2H-1,2,3-triazole-4-carboxamide

To an oven-dried flask under a nitrogen atmosphere was added N,O-dimethylhydroxylamine hydrochloride (2.8 g, 28.6 mmol) to which a solution of trimethylaluminum (2.0 M in toluene, 14.3 mL, 28.6 mmol) was added at 0° C. and stirred for 30 min. Ethyl 5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazole-4-carboxylate (i.e. the product of Step A, 4.0 g, 14.3 mmol) was added and the resulting solution was stirred at 23° C. for 4 h. The reaction mixture was cooled to 0° C. and carefully quenched by the dropwise addition of water (2 mL). Dichloromethane, (50 mL), sodium sulfate and water (3 mL) were added sequentially to the mixture which was then stirred for 20 min. at 23° C. The mixture was dried (Na_2SO_4 and $MgSO_4$) and concentrated under reduced pressure to obtain the title compound (3.7 g) as an orange solid.

^{1}H NMR δ 1.46-1.51 (m, 3H), 3.39 (s, 3H), 3.86 (s, 3H), 4.43-4.49 (m, 2H), 7.12-7.18 (m, 2H), 7.93-7.98 (m, 2H).

Step C: Preparation of [5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazol-4-yl][2-(trifluoromethyl)-4-pyridinyl]methanone

A solution of isopropylmagnesium chloride lithium chloride complex (1.3 M in THF, 8.5 mL, 11.0 mmol) was added to a solution of 4-iodo-2-(trifluoromethyl)pyridine (3.0 g, 11.0 mmol) in tetrahydrofuran (10 mL) cooled to 0° C. After 10 minutes, the solution was stirred at 23° C. for 35 min. The dark reddish brown solution was then cooled to −78° C. A solution of 5-ethoxy-2-(4-fluorophenyl)-N-methoxy-N-methyl-2H-1,2,3-triazole-4-carboxamide (i.e. the product of Step B, 2.5 g, 8.5 mmol) in tetrahydrofuran (25 mL) was added. The solution was stirred at 23° C. for 22 h. The reaction was quenched by the addition of a saturated aqueous ammonium chloride solution (10 mL) and water (10 mL). The mixture was extracted with ethyl acetate (2×40 mL), dried ($MgSO_4$) and concentrated under reduced pressure to obtain the crude product. The crude residue was purified by chromatography on silica gel eluting with 0 to 20% ethyl acetate in hexanes to afford the title compound (1.8 g) as a colorless solid.

^{1}H NMR δ 1.53-1.58 (t, 3H), 4.54-4.60 (m, 2H), 7.19-7.24 (m, 2H), 8.00-8.04 (m, 2H), 8.22-8.26 (m, 1H), 8.45-8.47 (m, 1H), 8.94-8.98 (m, 1H).

Step D: Preparation of 4-[[5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine

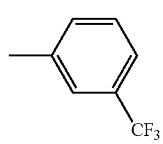
To a solution of [5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazol-4-yl][2-(trifluoromethyl)-4-pyridinyl]methanone (i.e. the product of Step C, 2.7 g, 7.1 mmol) in acetic acid (15 mL) was added iodine (1.8 g, 7.1 mmol) and hypophosphorous acid (50% in water, 3.1 mL, 28.4 mmol). The mixture was heated to 110° C. under a nitrogen atmosphere for 6 h. The reaction mixture was cooled to 23° C. and neutralized to ~pH 7 with 1 M NaOH and a saturated aqueous sodium bicarbonate solution. The mixture was extracted with ethyl acetate (2×15 mL), dried ($MgSO_4$) and concentrated under reduced pressure. The crude residue was purified by chromatography on silica gel eluting with 0 to 20% ethyl acetate in hexanes to afford the title compound (2.1 g) as an off-white solid.

^{1}H NMR δ 1.39-1.44 (t, 3H), 4.08 (s, 2H), 4.33-4.39 (m, 2H), 7.09-7.15 (m, 2H), 7.42-7.46 (m, 1H), 7.66-7.68 (m, 1H), 7.84-7.88 (m, 2H), 8.63-8.66 (m, 1H).

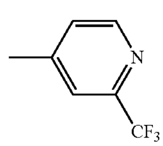
By the procedures described herein together with methods known in the art, the following compounds of Tables 1 to 126 can be prepared. The following abbreviations are used in the Tables which follow: n means normal, i means iso, Me means methyl, Et means ethyl, Pr means propyl, i-Pr means isopropyl, Ph means phenyl, OMe means methoxy, OEt means ethoxy and SMe means methylthio.

In the following Tables 1 to 125, J-1A, J-2A, J-10A, J-17A, J-17B, J-18A, J-18B, J-20A, J-22A and J-29A refer to the following structures:

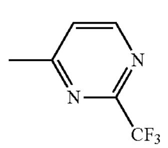
J-1A



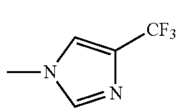
J-2A



J-10A



J-17A



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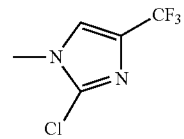
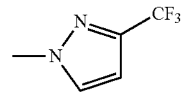
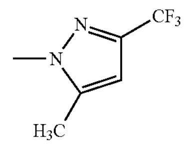
J-17B



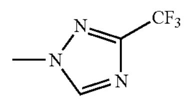
J-18A



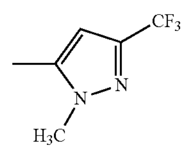
J-18B



J-20A



J-22A



J-29A

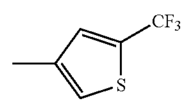
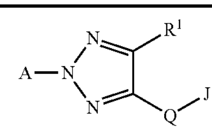


TABLE 1



1

J is J-2A; Q is O; R^1 is Me; and A is

A
Ph(4-F)
Ph(4-CF_3)
Ph(4-Cl)
Ph(4-Br)
Ph(4-SF_5)
Ph(4-OCF_3)
Ph(4-SCH_3)
Ph(4-OCH_3)
Ph(4-CN)
Ph(4-Me)
Ph
Ph(3-F)
Ph(3-CF_3)
Ph(3-Cl)
Ph(3-Br)
Ph(3-SF_5)
Ph(3-OCF_3)
Ph(3-SMe)
Ph(3-OMe)
Ph(3-CN)
Ph(3-Me)
Ph(2-F)

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A
Ph(2-CF_3)
Ph(2-Cl)
Ph(2-Br)
Ph(2,4-di-F)
Ph(3,4-di-F)
Ph(2,5-di-F)
Ph(2,4,6-tri-F)
Ph(2-Cl,4-F)
Ph(3-Cl,4-F)
Ph(4-F,3-CF_3)
Ph(2-F,4-CF_3)
Ph(3-F,4-CF_3)
Ph(3-Cl,4-CF_3)
Ph(2-Cl,4-CF_3)
Ph(4-Cl,3-CF_3)
2-Pyridinyl
3-Pyridinyl
4-Pyridinyl
2-Pyridinyl(5-CF_3)
2-Pyridinyl(5-Cl)
4-Pyridinyl(2-CF_3)
4-Pyridinyl(2-Cl)
2-Pyridinyl(6-CF_3)
3-Pyridinyl(5-CF_3)
5-Pyridinyl(2-CF_3)
2-Pyrazinyl(5-CF_3)
3-Pyridazinyl(6-CF_3)
2-Pyridinyl(5-F)
4-Pyridinyl(2-F)
2-Pyridinyl(6-F)
3-Pyridinyl(5-F)
3-Pyridinyl(6-F)
2-Pyrimidinyl(5-Cl)
2-Pyrimidinyl(5-CF_3)
4-Pyrimidinyl(2-CF_3)
2-Pyrimidinyl(4-CF_3)
2-Thienyl(5-Cl)
2-Thienyl(5-CF_3)
2-Thiazolyl(4-CF_3)
1,2,4-Thiadiazol-5-yl(3-CF_3)

Table 2 is constructed in the same manner except that the Row Heading "J is J-2A; Q is O, R^1 is Me; and A is" is replaced with the Row Heading listed for Table 2 below (i.e. "J is J-2A; Q is O; R^1 is Et; and A is"). Therefore the first entry in Table 2 is a compound of Formula 1 wherein R^1 is Et; Q is O; A is Ph(4-F) (i.e. 4-fluorophenyl); and J is J-2A. Tables 3 through 125 are constructed similarly.

Table	Row Heading
2	J is J-2A; Q is O; R^1 is Et; and A is
3	J is J-2A; Q is O; R^1 is n-Pr; and A is
4	J is J-2A; Q is O; R^1 is i-Pr; and A is
5	J is J-2A; Q is O; R^1 is OMe; and A is
6	J is J-2A; Q is O; R^1 is SMe; and A is
7	J is J-2A; Q is O; R^1 is $OCHF_2$; and A is
8	J is J-2A; Q is O; R^1 is CH_2OCH_3; and A is
9	J is J-2A; Q is O; R^1 is OEt; and A is
10	J is J-2A; Q is O; R^1 is OCH_2CF_3; and A is
11	J is J-2A; Q is CH_2; R^1 is Me; and A is
12	J is J-2A; Q is CH_2; R^1 is Et; and A is
13	J is J-2A; Q is CH_2; R^1 is n-Pr; and A is
14	J is J-2A; Q is CH_2; R^1 is i-Pr; and A is
15	J is J-2A; Q is CH_2; R^1 is OMe; and A is
16	J is J-2A; Q is CH_2; R^1 is SMe; and A is
17	J is J-2A; Q is CH_2; R^1 is $OCHF_2$; and A is
18	J is J-2A; Q is CH_2; R^1 is CH_2OCH_3; and A is
19	J is J-2A; Q is CH_2; R^1 is OEt; and A is
20	J is J-2A; Q is CH_2; R^1 is OCH_2CF_3; and A is
21	J is J-1A; Q is O; R^1 is Me; and A is
22	J is J-1A; Q is O; R^1 is Et; and A is
23	J is J-1A; Q is O; R^1 is n-Pr; and A is
24	J is J-1A; Q is O; R^1 is i-Pr; and A is
25	J is J-1A; Q is O; R^1 is OMe; and A is
26	J is J-1A; Q is O; R^1 is SMe; and A is
27	J is J-1A; Q is O; R^1 is OCHF2; and A is
28	J is J-1A; Q is O; R^1 is CH_2OCH_3; and A is
29	J is J-1A; Q is O; R^1 is OEt; and A is
30	J is J-1A; Q is O; R^1 is OCH_2CF_3; and A is
31	J is J-1A; Q is CH_2; R^1 is Me; and A is
32	J is J-1A; Q is CH_2; R^1 is Et; and A is
33	J is J-1A; Q is CH_2; R^1 is n-Pr; and A is
34	J is J-1A; Q is CH_2; R^1 is i-Pr; and A is
35	J is J-1A; Q is CH_2; R^1 is OMe; and A is
36	J is J-1A; Q is CH_2; R^1 is SMe; and A is
37	J is J-1A; Q is CH_2; R^1 is $OCHF_2$; and A is
38	J is J-1A; Q is CH_2; R^1 is CH_2OCH_3; and A is
39	J is J-1A; Q is CH_2; R^1 is OEt; and A is
40	J is J-1A; Q is CH_2; R^1 is OCH_2CF_3; and A is
41	J is J-10A; Q is O; R^1 is Me; and A is
42	J is J-10A; Q is O; R^1 is Et; and A is
43	J is J-10A; Q is O; R^1 is OMe; and A is
44	J is J-10A Q is O; R^1 is $OCHF_2$; and A is
45	J is J-10A; Q is CH_2; R^1 is Me; and A is
46	J is J-10A; Q isCH2; R^1 is Et; and A is
47	J is J-10A; Q is CH_2; R^1 is OMe; and A is
48	J is J-10A; Q is CH_2; R^1 is $OCHF_2$; and A is
49	J is J-29A; Q is O; R^1 is Me; and A is
50	J is J-29A; Q is O; R^1 is Et; and A is
51	J is J-29A; Q is O; R^1 is OMe; and A is
52	J is J-29A; Q is O; R^1 is $OCHF_2$; and A is
53	J is J-29A; Q is CH_2; R^1 is Me; and A is
54	J is J-29A; Q is CH_2; R^1 is Et; and A is
55	J is J-29A; Q is CH_2; R^1 is OMe; and A is
56	J is J-29A; Q is CH_2; R^1 is $OCHF_2$; and A is
57	J is J-2A; Q is C═O; R^1 is Me; and A is
58	J is J-2A; Q is C═O; R^1 is Et; and A is
59	J is J-2A; Q is C═O; R^1 is OMe; and A is
60	J is J-2A; Q is C═O; R^1 is $OCHF_2$; and A is
61	J is J-1A; Q is C═O; R^1 is Me; and A is
62	J is J-1A; Q is C═O; R^1 is Et; and A is
63	J is J-1A; Q is C═O; R^1 is OMe; and A is
64	J is J-JA; Q is C═O; R^1 is $OCHF_2$; and A is
65	J is J-2A; Q is S; R^1 is Me; and A is
66	J is J-2A; Q is S; R^1 is Et; and A is
67	J is J-2A; Q is S; R^1 is OMe; and A is
68	J is J-2A; Q is S; R^1 is $OCHF_2$; and A is
69	J is J-1A; Q is S; R^1 is Me; and A is
70	J is J-1A; Q is S; R^1 is Et; and A is
71	J is J-1A; Q is S; R^1 is OMe; and A is
72	J is J-1A; Q is S; R^1 is $OCHF_2$; and A is
73	J is J-2A; Q is NH; R^1 is Me; and A is
74	J is J-2A; Q is NH; R^1 is Et; and A is
75	J is J-2A; Q is NH; R^1 is OMe; and A is
76	J is J-2A; Q is NH; R^1 is $OCHF_2$; and A is
77	J is J-1A; Q is NH; R^1 is Me; and A is
78	J is J-1A; Q is NH; R^1 is Et; and A is
79	J is J-1A; Q is NH; R^1 is OMe; and A is
80	J is J-1A; Q is NH; R^1 is $OCHF_2$; and A is
81	J is J-2A; Q is CHF; R^1 is Me; and A is
82	J is J-2A; Q is CHF; R^1 is Et; and A is
83	J is J-2A; Q is CHF; R^1 is OMe; and A is
84	J is J-2A; Q is CHF; R^1 is $OCHF_2$; and A is
85	J is J-1A; Q is CHF; R^1 is Me; and A is
86	J is J-1A; Q is CHF; R^1 is Et; and A is
87	J is J-1A; Q is CHF; R^1 is OMe; and A is
88	J is J-1A; Q is CHF; R^1 is $OCHF_2$; and A is
89	J is J-22A; Q is O; R^1 is Me; and A is
90	J is J-22A; Q is O; R^1 is Et; and A is
91	J is J-22A; Q is O; R^1 is OMe; and A is
92	J is J-22A; Q is O; R^1 is $OCHF_2$; and A is
93	J is J-22A; Q is CH_2; R^1 is Me; and A is
94	J is J-22A; Q is CH_2; R^1 is Et; and A is
95	J is J-22A; Q is CH_2; R^1 is OMe; and A is
96	J is J-22A; Q is CH_2; R^1 is $OCHF_2$; and A is
97	J is J-2A; Q is O; R^1 is Cl; and A is
98	J is J-2A; Q is CH_2; R^1 is Cl; and A is
99	J is J-1A; Q is O; R^1 is Br; and A is
100	J is J-1A; Q is CH_2; R^1 is Br; and A is

-continued

Table	Row Heading
101	J is J-18A; Q is CH_2; R^1 is Et; and A is
102	J is J-18A; Q is CH_2; R^1 is Me; and A is
103	J is J-18A; Q is CH_2; R^1 is OMe; and A is
104	J is J-18A; Q is CH_2; R^1 is $OCHF_2$; and A is
105	J is J-18A; Q is CH_2; R^1 is Cl; and A is
106	J is J-20A; Q is CH_2; R^1 is Et; and A is
107	J is J-20A; Q is CH_2; R^1 is Me; and A is
108	J is J-20A; Q is CH_2; R^1 is OMe; and A is
109	J is J-20A; Q is CH_2; R^1 is $OCHF_2$; and A is
110	J is J-20A; Q is CH_2; R^1 is Cl; and A is
111	J is J-17A; Q is CH_2; R^1 is Et; and A is
112	J is J-17A; Q is CH_2; R^1 is Me; and A is
113	J is J-17A; Q is CH_2; R^1 is OMe; and A is
114	J is J-17A; Q is CH_2; R^1 is $OCHF_2$; and A is
115	J is J-17A; Q is CH_2; R^1 is Cl; and A is
116	J is J-17B; Q is CH_2; R^1 is Et; and A is
117	J is J-17B; Q is CH_2; R^1 is Me; and A is
118	J is J-17B; Q is CH_2; R^1 is OMe; and A is
119	J is J-17B; Q is CH_2; R^1 is $OCHF_2$; and A is
120	J is J-17B; Q is CH_2; R^1 is Cl; and A is
121	J is J-18B; Q is CH_2; R^1 is Et; and A is
122	J is J-18B; Q is CH_2; R^1 is Me; and A is
123	J is J-18B; Q is CH_2; R^1 is OMe; and A is
124	J is J-18B; Q is CH_2; R^1 is $OCHF_2$; and A is
125	J is J-18B; Q is CH_2; R^1 is Cl; and A is

A compound of this invention will generally be used as a herbicidal active ingredient in a composition, i.e. formulation, with at least one additional component selected from the group consisting of surfactants, solid diluents and liquid diluents, which serves as a carrier. The formulation or composition ingredients are selected to be consistent with the physical properties of the active ingredient, mode of application and environmental factors such as soil type, moisture and temperature.

Useful formulations include both liquid and solid compositions. Liquid compositions include solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions and/or suspoemulsions) and the like, which optionally can be thickened into gels. The general types of aqueous liquid compositions are soluble concentrate, suspension concentrate, capsule suspension, concentrated emulsion, microemulsion and suspo-emulsion. The general types of nonaqueous liquid compositions are emulsifiable concentrate, microemulsifiable concentrate, dispersible concentrate and oil dispersion.

The general types of solid compositions are dusts, powders, granules, pellets, prills, pastilles, tablets, filled films (including seed coatings) and the like, which can be water-dispersible ("wettable") or water-soluble. Films and coatings formed from film-forming solutions or flowable suspensions are particularly useful for seed treatment. Active ingredient can be (micro)encapsulated and further formed into a suspension or solid formulation; alternatively the entire formulation of active ingredient can be encapsulated (or "overcoated"). Encapsulation can control or delay release of the active ingredient. An emulsifiable granule combines the advantages of both an emulsifiable concentrate formulation and a dry granular formulation. High-strength compositions are primarily used as intermediates for further formulation.

Sprayable formulations are typically extended in a suitable medium before spraying. Such liquid and solid formulations are formulated to be readily diluted in the spray medium, usually water. Spray volumes can range from about from about one to several thousand liters per hectare, but more typically are in the range from about ten to several hundred liters per hectare. Sprayable formulations can be tank mixed with water or another suitable medium for foliar treatment by aerial or ground application, or for application to the growing medium of the plant. Liquid and dry formulations can be metered directly into drip irrigation systems or metered into the furrow during planting.

The formulations will typically contain effective amounts of active ingredient, diluent and surfactant within the following approximate ranges which add up to 100 percent by weight.

	Weight Percent		
	Active Ingredient	Diluent	Surfactant
Water-Dispersible and Water-soluble Granules, Tablets and Powders	0.001-90	0-99.999	0-15
Oil Dispersions, Suspensions, Emulsions, Solutions (including Emulsifiable Concentrates)	1-50	40-99	0-50
Dusts	1-25	70-99	0-5
Granules and Pellets	0.001-99	5-99.999	0-15
High Strength Compositions	90-99	0-10	0-2

Solid diluents include, for example, clays such as bentonite, montmorillonite, attapulgite and kaolin, gypsum, cellulose, titanium dioxide, zinc oxide, starch, dextrin, sugars (e.g., lactose, sucrose), silica, talc, mica, diatomaceous earth, urea, calcium carbonate, sodium carbonate and bicarbonate, and sodium sulfate. Typical solid diluents are described in Watkins et al., *Handbook of Insecticide Dust Diluents and Carriers,* 2nd Ed., Dorland Books, Caldwell, N.J.

Liquid diluents include, for example, water, N,N-dimethylalkanamides (e.g., N,N-dimethylformamide), limonene, dimethyl sulfoxide, N-alkylpyrrolidones (e.g., N-methylpyrrolidinone), ethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, polypropylene glycol, propylene carbonate, butylene carbonate, paraffins (e.g., white mineral oils, normal paraffins, isoparaffins), alkylbenzenes, alkylnaphthalenes, glycerine, glycerol triacetate, sorbitol, aromatic hydrocarbons, dearomatized aliphatics, alkylbenzenes, alkylnaphthalenes, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, acetates such as isoamyl acetate, hexyl acetate, heptyl acetate, octyl acetate, nonyl acetate, tridecyl acetate and isobornyl acetate, other esters such as alkylated lactate esters, dibasic esters and γ-butyrolactone, and alcohols, which can be linear, branched, saturated or unsaturated, such as methanol, ethanol, n-propanol, isopropyl alcohol, n-butanol, isobutyl alcohol, n-hexanol, 2-ethylhexanol, n-octanol, decanol, isodecyl alcohol, isooctadecanol, cetyl alcohol, lauryl alcohol, tridecyl alcohol, oleyl alcohol, cyclohexanol, tetrahydrofurfuryl alcohol, diacetone alcohol and benzyl alcohol. Liquid diluents also include glycerol esters of saturated and unsaturated fatty acids (typically C_6-C_{22}), such as plant seed and fruit oils (e.g., oils of olive, castor, linseed, sesame, corn (maize), peanut, sunflower, grapeseed, safflower, cottonseed, soybean, rapeseed, coconut and palm kernel), animal-sourced fats (e.g., beef tallow, pork tallow, lard, cod liver oil, fish oil), and mixtures thereof. Liquid diluents also include alkylated fatty acids (e.g., methylated, ethylated, butylated) wherein the fatty acids may be obtained by hydrolysis of glycerol esters from plant and animal sources, and can be purified by distillation. Typical liquid diluents are described in Marsden, *Solvents Guide,* 2nd Ed., Interscience, New York, 1950.

The solid and liquid compositions of the present invention often include one or more surfactants. When added to a liquid, surfactants (also known as "surface-active agents") generally modify, most often reduce, the surface tension of the liquid. Depending on the nature of the hydrophilic and lipophilic groups in a surfactant molecule, surfactants can be useful as wetting agents, dispersants, emulsifiers or defoaming agents.

Surfactants can be classified as nonionic, anionic or cationic. Nonionic surfactants useful for the present compositions include, but are not limited to: alcohol alkoxylates such as alcohol alkoxylates based on natural and synthetic alcohols (which may be branched or linear) and prepared from the alcohols and ethylene oxide, propylene oxide, butylene oxide or mixtures thereof; amine ethoxylates, alkanolamides and ethoxylated alkanolamides; alkoxylated triglycerides such as ethoxylated soybean, castor and rapeseed oils; alkylphenol alkoxylates such as octylphenol ethoxylates, nonylphenol ethoxylates, dinonyl phenol ethoxylates and dodecyl phenol ethoxylates (prepared from the phenols and ethylene oxide, propylene oxide, butylene oxide or mixtures thereof); block polymers prepared from ethylene oxide or propylene oxide and reverse block polymers where the terminal blocks are prepared from propylene oxide; ethoxylated fatty acids; ethoxylated fatty esters and oils; ethoxylated methyl esters; ethoxylated tristyrylphenol (including those prepared from ethylene oxide, propylene oxide, butylene oxide or mixtures thereof); fatty acid esters, glycerol esters, lanolin-based derivatives, polyethoxylate esters such as polyethoxylated sorbitan fatty acid esters, polyethoxylated sorbitol fatty acid esters and polyethoxylated glycerol fatty acid esters; other sorbitan derivatives such as sorbitan esters; polymeric surfactants such as random copolymers, block copolymers, alkyd peg (polyethylene glycol) resins, graft or comb polymers and star polymers; polyethylene glycols (pegs); polyethylene glycol fatty acid esters; silicone-based surfactants; and sugar-derivatives such as sucrose esters, alkyl polyglycosides and alkyl polysaccharides.

Useful anionic surfactants include, but are not limited to: alkylaryl sulfonic acids and their salts; carboxylated alcohol or alkylphenol ethoxylates; diphenyl sulfonate derivatives; lignin and lignin derivatives such as lignosulfonates; maleic or succinic acids or their anhydrides; olefin sulfonates; phosphate esters such as phosphate esters of alcohol alkoxylates, phosphate esters of alkylphenol alkoxylates and phosphate esters of styryl phenol ethoxylates; protein-based surfactants; sarcosine derivatives; styryl phenol ether sulfate; sulfates and sulfonates of oils and fatty acids; sulfates and sulfonates of ethoxylated alkylphenols; sulfates of alcohols; sulfates of ethoxylated alcohols; sulfonates of amines and amides such as N,N-alkyltaurates; sulfonates of benzene, cumene, toluene, xylene, and dodecyl and tridecylbenzenes; sulfonates of condensed naphthalenes; sulfonates of naphthalene and alkyl naphthalene; sulfonates of fractionated petroleum; sulfosuccinamates; and sulfosuccinates and their derivatives such as dialkyl sulfosuccinate salts.

Useful cationic surfactants include, but are not limited to: amides and ethoxylated amides; amines such as N-alkyl propanediamines, tripropylenetriamines and dipropylenetetramines, and ethoxylated amines, ethoxylated diamines and propoxylated amines (prepared from the amines and ethylene oxide, propylene oxide, butylene oxide or mixtures thereof); amine salts such as amine acetates and diamine salts; quaternary ammonium salts such as quaternary salts, ethoxylated quaternary salts and diquaternary salts; and amine oxides such as alkyldimethylamine oxides and bis-(2-hydroxyethyl)-alkylamine oxides.

Also useful for the present compositions are mixtures of nonionic and anionic surfactants or mixtures of nonionic and cationic surfactants. Nonionic, anionic and cationic surfactants and their recommended uses are disclosed in a variety of published references including *McCutcheon's Emulsifiers and Detergents*, annual American and International Editions published by McCutcheon's Division, The Manufacturing Confectioner Publishing Co.; Sisely and Wood, *Encyclopedia of Surface Active Agents*, Chemical Publ. Co., Inc., New York, 1964; and A. S. Davidson and B. Milwidsky, *Synthetic Detergents*, Seventh Edition, John Wiley and Sons, New York, 1987.

Compositions of this invention may also contain formulation auxiliaries and additives, known to those skilled in the art as formulation aids (some of which may be considered to also function as solid diluents, liquid diluents or surfactants). Such formulation auxiliaries and additives may control: pH (buffers), foaming during processing (antifoams such polyorganosiloxanes), sedimentation of active ingredients (suspending agents), viscosity (thixotropic thickeners), in-container microbial growth (antimicrobials), product freezing (antifreezes), color (dyes/pigment dispersions), wash-off (film formers or stickers), evaporation (evaporation retardants), and other formulation attributes. Film formers include, for example, polyvinyl acetates, polyvinyl acetate copolymers, polyvinylpyrrolidone-vinyl acetate copolymer, polyvinyl alcohols, polyvinyl alcohol copolymers and waxes. Examples of formulation auxiliaries and additives include those listed in *McCutcheon's Volume 2: Functional Materials*, annual International and North American editions published by McCutcheon's Division, The Manufacturing Confectioner Publishing Co.; and PCT Publication WO 03/024222.

The compound of Formula 1 and any other active ingredients are typically incorporated into the present compositions by dissolving the active ingredient in a solvent or by grinding in a liquid or dry diluent. Solutions, including emulsifiable concentrates, can be prepared by simply mixing the ingredients. If the solvent of a liquid composition intended for use as an emulsifiable concentrate is water-immiscible, an emulsifier is typically added to emulsify the active-containing solvent upon dilution with water. Active ingredient slurries, with particle diameters of up to 2,000 μm can be wet milled using media mills to obtain particles with average diameters below 3 μm. Aqueous slurries can be made into finished suspension concentrates (see, for example, U.S. Pat. No. 3,060,084) or further processed by spray drying to form water-dispersible granules. Dry formulations usually require dry milling processes, which produce average particle diameters in the 2 to 10 μm range. Dusts and powders can be prepared by blending and usually grinding (such as with a hammer mill or fluid-energy mill). Granules and pellets can be prepared by spraying the active material upon preformed granular carriers or by agglomeration techniques. See Browning, "Agglomeration", *Chemical Engineering*, Dec. 4, 1967, pp 147-48, *Perry's Chemical Engineer's Handbook,* 4th Ed., McGraw-Hill, New York, 1963, pages 8-57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. Pat. No. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. Pat. No. 4,144,050, U.S. Pat. No. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. Pat. No. 5,180,587, U.S. Pat. No. 5,232,701 and U.S. Pat. No. 5,208,030. Films can be prepared as taught in GB 2,095,558 and U.S. Pat. No. 3,299,566.

For further information regarding the art of formulation, see T. S. Woods, "The Formulator's Toolbox—Product Forms for Modern Agriculture" in *Pesticide Chemistry and*

Bioscience, The Food-Environment Challenge, T. Brooks and T. R. Roberts, Eds., Proceedings of the 9th International Congress on Pesticide Chemistry, The Royal Society of Chemistry, Cambridge, 1999, pp. 120-133. See also U.S. Pat. No. 3,235,361, Col. 6, line 16 through Col. 7, line 19 and Examples 10-41; U.S. Pat. No. 3,309,192, Col. 5, line 43 through Col. 7, line 62 and Examples 8, 12, 15, 39, 41, 52, 53, 58, 132, 138-140, 162-164, 166, 167 and 169-182; U.S. Pat. No. 2,891,855, Col. 3, line 66 through Col. 5, line 17 and Examples 1-4; Klingman, *Weed Control as a Science*, John Wiley and Sons, Inc., New York, 1961, pp 81-96; Hance et al., *Weed Control Handbook*, 8th Ed., Blackwell Scientific Publications, Oxford, 1989; and *Developments in formulation technology*, PJB Publications, Richmond, UK, 2000.

In the following Examples, all percentages are by weight and all formulations are prepared in conventional ways. Compound numbers refer to compounds in Index Tables A and B. Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Percentages are by weight except where otherwise indicated.

Example A

High Strength Concentrate

Compound 129	98.5%
silica aerogel	0.5%
synthetic amorphous fine silica	1.0%

Example B

Wettable Powder

Compound 14	65.0%
dodecylphenol polyethylene glycol ether	2.0%
sodium ligninsulfonate	4.0%
sodium silicoaluminate	6.0%
montmorillonite (calcined)	23.0%

Example C

Granule

Compound 15	10.0%
attapulgite granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25-50 sieves)	90.0%

Example D

Extruded Pellet

Compound 16	25.0%
anhydrous sodium sulfate	10.0%
crude calcium ligninsulfonate	5.0%
sodium alkylnaphthalenesulfonate	1.0%
calcium/magnesium bentonite	59.0%

Example E

Emulsifiable Concentrate

Compound 47	10.0%
polyoxyethylene sorbitol hexoleate	20.0%
C_6-C_{10} fatty acid methyl ester	70.0%

Example F

Microemulsion

Compound 129	5.0%
polyvinylpyrrolidone-vinyl copolymer acetate	30.0%
alkylpolyglycoside	30.0%
glyceryl monooleate	15.0%
water	20.0%

Test results indicate that the compounds of the present invention are highly active preemergent and/or postemergent herbicides and/or plant growth regulants. The compounds of the intention generally show highest activity for postemergence weed control (i.e. applied after weed seedlings emerge from the soil) and preemergence weed control (i.e. applied before weed seedlings emerge from the soil). Many of them have utility for broad-spectrum pre- and/or postemergence weed control in areas where complete control of all vegetation is desired such as around fuel storage tanks, industrial storage areas, parking lots, drive-in theaters, air fields, river banks, irrigation and other waterways, around billboards and highway and railroad structures. Many of the compounds of this invention, by virtue of selective metabolism in crops versus weeds, or by selective activity at the locus of physiological inhibition in crops and weeds, or by selective placement on or within the environment of a mixture of crops and weeds, are useful for the selective control of grass and broadleaf weeds within a crop/weed mixture. One skilled in the art will recognize that the preferred combination of these selectivity factors within a compound or group of compounds can readily be determined by performing routine biological and/or biochemical assays. Compounds of this invention may show tolerance to important agronomic crops including, but is not limited to, alfalfa, barley, cotton, wheat, rape, sugar beets, corn (maize), *sorghum*, soybeans, rice, oats, peanuts, vegetables, tomato, potato, perennial plantation crops including coffee, cocoa, oil palm, rubber, sugarcane, citrus, grapes, fruit trees, nut trees, banana, plantain, pineapple, hops, tea and forests such as *eucalyptus* and conifers (e.g., loblolly pine), and turf species (e.g., Kentucky bluegrass, St. Augustine grass, Kentucky fescue and Bermuda grass). Compounds of this invention can be used in crops genetically transformed or bred to incorporate resistance to herbicides, express proteins toxic to invertebrate pests (such as *Bacillus thuringiensis* toxin), and/or express other useful traits. Those skilled in the art will appreciate that not all compounds are equally effective against all weeds. Alternatively, the subject compounds are useful to modify plant growth.

As the compounds of the invention have both preemergent and postemergent herbicidal activity, to control undesired vegetation by killing or injuring the vegetation or reducing its growth, the compounds can be usefully applied by a variety of methods involving contacting a herbicidally effective amount of a compound of the invention, or a composition comprising said compound and at least one of a surfactant, a solid diluent or a liquid diluent, to the foliage or other part of the undesired vegetation or to the environment of the undesired vegetation such as the soil or water in which the undesired vegetation is growing or which surrounds the seed or other propagule of the undesired vegetation.

A herbicidally effective amount of the compounds of this invention is determined by a number of factors. These factors include: formulation selected, method of application, amount and type of vegetation present, growing conditions, etc. In general, a herbicidally effective amount of compounds of this invention is about 0.001 to 20 kg/ha with a preferred range of about 0.004 to 1 kg/ha. One skilled in the art can easily determine the herbicidally effective amount necessary for the desired level of weed control.

Compounds of this invention can also be mixed with one or more other biologically active compounds or agents including herbicides, herbicide safeners, fungicides, insecticides, nematocides, bactericides, acaricides, growth regulators such as insect molting inhibitors and rooting stimulants, chemosterilants, semiochemicals, repellents, attractants, pheromones, feeding stimulants, plant nutrients, other biologically active compounds or entomopathogenic bacteria, virus or fungi to form a multi-component pesticide giving an even broader spectrum of agricultural protection. Mixtures of the compounds of the invention with other herbicides can broaden the spectrum of activity against additional weed species, and suppress the proliferation of any resistant biotypes. Thus the present invention also pertains to a composition comprising a compound of Formula 1 (in a herbicidally effective amount) and at least one additional biologically active compound or agent (in a biologically effective amount) and can further comprise at least one of a surfactant, a solid diluent or a liquid diluent. The other biologically active compounds or agents can be formulated in compositions comprising at least one of a surfactant, solid or liquid diluent. For mixtures of the present invention, one or more other biologically active compounds or agents can be formulated together with a compound of Formula 1, to form a premix, or one or more other biologically active compounds or agents can be formulated separately from the compound of Formula 1, and the formulations combined together before application (e.g., in a spray tank) or, alternatively, applied in succession.

A mixture of one or more of the following herbicides with a compound of this invention may be particularly useful for weed control: acetochlor, acifluorfen and its sodium salt, aclonifen, acrolein (2-propenal), alachlor, alloxydim, ametryn, amicarbazone, amidosulfuron, aminocyclopyrachlor and its esters (e.g., methyl, ethyl) and salts (e.g., sodium, potassium), aminopyralid, amitrole, ammonium sulfamate, anilofos, asulam, atrazine, azimsulfuron, beflubutamid, benazolin, benazolin-ethyl, bencarbazone, benfluralin, benfuresate, bensulfuron-methyl, bensulide, bentazone, benzobicyclon, benzofenap, bicyclopyrone, bifenox, bilanafos, bispyribac and its sodium salt, bromacil, bromobutide, bromofenoxim, bromoxynil, bromoxynil octanoate, butachlor, butafenacil, butamifos, butralin, butroxydim, butylate, cafenstrole, carbetamide, carfentrazone-ethyl, catechin, chlomethoxyfen, chloramben, chlorbromuron, chlorflurenol-methyl, chloridazon, chlorimuron-ethyl, chlorotoluron, chlorpropham, chlorsulfuron, chlorthal-dimethyl, chlorthiamid, cinidon-ethyl, cinmethylin, cinosulfuron, clacyfos, clefoxydim, clethodim, cyclopyrimorate (6-chloro-3-(2-cyclopropyl-6-methylphenoxy)-4-pyridazinyl 4-morpholinecarboxylate), clodinafop-propargyl, clomazone, clomeprop, clopyralid, clopyralid-olamine, cloransulam-methyl, cumyluron, cyanazine, cycloate, cyclosulfamuron, cycloxydim, cyhalofop-butyl, 2,4-D and its butotyl, butyl, isoctyl and isopropyl esters and its dimethylammonium, diolamine and trolamine salts, daimuron, dalapon, dalapon-sodium, dazomet, 2,4-DB and its dimethylammonium, potassium and sodium salts, desmedipham, desmetryn, dicamba and its diglycolammonium, dimethylammonium, potassium and sodium salts, dichlobenil, dichlorprop, diclofop-methyl, diclosulam, difenzoquat metilsulfate, diflufenican, diflufenzopyr, dimefuron, dimepiperate, dimethachlor, dimethametryn, dimethenamid, dimethenamid-P, dimethipin, dimethylarsinic acid and its sodium salt, dinitramine, dinoterb, diphenamid, diquat dibromide, dithiopyr, diuron, DNOC, endothal, EPTC, esprocarb, ethalfluralin, ethametsulfuron-methyl, ethiozin, ethofumesate, ethoxyfen, ethoxysulfuron, etobenzanid, fenoxaprop-ethyl, fenoxaprop-P-ethyl, fenoxasulfone, fenquinotrione (2-[[8-chloro-3,4-dihydro-4-(4-methoxyphenyl)-3-oxo-2-quinoxalinyl]carbonyl]-1,3-cyclohexanedione), fentrazamide, fenuron, fenuron-TCA, flamprop-methyl, flamprop-M-isopropyl, flamprop-M-methyl, flazasulfuron, florasulam, fluazifop-butyl, fluazifop-P-butyl, fluazolate, flucarbazone, flucetosulfuron, fluchloralin, flufenacet, flufenpyr, flufenpyr-ethyl, flumetsulam, flumiclorac-pentyl, flumioxazin, fluometuron, fluoroglycofen-ethyl, flupoxam, flupyrsulfuron-methyl and its sodium salt, flurenol, flurenol-butyl, fluridone, flurochloridone, fluroxypyr, flurtamone, fluthiacet-methyl, fomesafen, foramsulfuron, fosamine-ammonium, glufosinate, glufosinate-ammonium, glyphosate and its salts such as ammonium, isopropylammonium, potassium, sodium (including sesquisodium) and trimesium (alternatively named sulfosate), halauxifen, halauxifen-methyl, halosulfuron-methyl, haloxyfop-etotyl, haloxyfop-methyl, hexazinone, imazamethabenz-methyl, imazamox, imazapic, imazapyr, imazaquin, imazaquin-ammonium, imazethapyr, imazethapyr-ammonium, imazosulfuron, indanofan, indaziflam, iofensulfuron, iodosulfuron-methyl, ioxynil, ioxynil octanoate, ioxynil-sodium, ipfencarbazone, isoproturon, isouron, isoxaben, isoxaflutole, isoxachlortole, lactofen, lenacil, linuron, maleic hydrazide, MCPA and its salts (e.g., MCPA-dimethylammonium, MCPA-potassium and MCPA-sodium, esters (e.g., MCPA-2-ethylhexyl, MCPA-butotyl) and thioesters (e.g., MCPA-thioethyl), MCPB and its salts (e.g., MCPB-sodium) and esters (e.g., MCPB-ethyl), mecoprop, mecoprop-P, mefenacet, mefluidide, mesosulfuron-methyl, mesotrione, metam-sodium, metamifop, metamitron, metazachlor, metazosulfuron, methabenzthiazuron, methiozolin, methylarsonic acid and its calcium, monoammonium, monosodium and disodium salts, methyldymron, metobenzuron, metobromuron, metolachlor, S-metolachlor, metosulam, metoxuron, metribuzin, metsulfuron-methyl, molinate, monolinuron, naproanilide, napropamide, naptalam, neburon, nicosulfuron, norflurazon, orbencarb, orthosulfamuron, oryzalin, oxadiargyl, oxadiazon, oxasulfuron, oxaziclomefone, oxyfluorfen, paraquat dichloride, pebulate, pelargonic acid, pendimethalin, penoxsulam, pentanochlor, pentoxazone, perfluidone, pethoxamid, pethoxyamid, phenmedipham, picloram, picloram-potassium, picolinafen, pinoxaden, piperophos, pretilachlor, primisulfuron-methyl, prodiamine, profoxydim, prometon, prometryn, propachlor, propanil, propaquizafop, propazine, propham, propisochlor, propoxycarbazone, propyzamide, prosulfocarb, prosulfuron, pyraclonil, pyraflufen-ethyl, pyrasulfotole, pyrazogyl, pyrazolynate, pyrazoxyfen, pyrazosulfuron-ethyl, pyribenzoxim, pyributicarb, pyridate, pyriftalid, pyriminobac-methyl, pyrimisulfan, pyrithiobac, pyrithiobac-sodium, pyroxasulfone, pyroxsulam, quinclorac, quinmerac, quinoclamine, quizalofop-ethyl, quizalofop-P-ethyl, quizalofop-P-tefuryl, rimsulfuron, saflufenacil, sethoxydim, siduron, simazine, simetryn, sulcotrione, sulfentrazone, sulfometuron-methyl, sulfosulfuron, 2,3,6-TBA, TCA, TCA-sodium, tebutam, tebuthiuron, tefuryltrione, tembotrione, tepraloxydim, terbacil, terbumeton, terbuthylazine, terbutryn, thenylchlor, thiazopyr, thiencarbazone, thifensulfuron-methyl, thiobencarb, tiafenacil (methyl N-[2-[[2-chloro-5-[3,6-dihydro-3-methyl-2,6-dioxo-4-(trifluoromethyl)-1(2H)-pyrimidinyl]-4-fluorophenyl]thio]-1-oxopropyl]-β-alaninate), tiocarbazil, topramezone, tralkoxydim, tri-allate, triafamone, triasulfuron, triaziflam, tribenuron-methyl, triclopyr, triclopyr-butotyl, triclopyr-triethylammonium, tridiphane, trietazine, trifloxysulfuron, trifluralin, triflusulfuron-methyl, tritosulfuron and vernolate. Other herbicides also include bioherbicides such as *Alternaria destruens* Simmons, *Colletotrichum gloeosporiodes* (Penz.) Penz. & Sacc., *Drechsiera monoceras* (MTB-951), *Myrothecium verrucaria* (Albertini & Schweinitz) Ditmar: Fries, *Phytophthora palmivora* (Butl.) Butl. and *Puccinia thlaspeos* Schub.

Compounds of this invention can also be used in combination with plant growth regulators such as aviglycine, N-(phenylmethyl)-1H-purin-6-amine, epocholeone, gibberellic acid, gibberellin A_4 and A_7, harpin protein, mepiquat chloride, prohexadione calcium, prohydrojasmon, sodium nitrophenolate and trinexapac-methyl, and plant growth modifying organisms such as *Bacillus cereus* strain BP01.

General references for agricultural protectants (i.e. herbicides, herbicide safeners, insecticides, fungicides, nematocides, acaricides and biological agents) include *The Pesticide Manual,* 13*th Edition*, C. D. S. Tomlin, Ed., British Crop Protection Council, Farnham, Surrey, U.K., 2003 and *The BioPesticide Manual,* 2*nd Edition*, L. G. Copping, Ed., British Crop Protection Council, Farnham, Surrey, U.K., 2001.

For embodiments where one or more of these various mixing partners are used, the weight ratio of these various mixing partners (in total) to the compound of Formula 1 is typically between about 1:3000 and about 3000:1. Of note are weight ratios between about 1:300 and about 300:1 (for example ratios between about 1:30 and about 30:1). One skilled in the art can easily determine through simple experimentation the biologically effective amounts of active ingredients necessary for the desired spectrum of biological activity. It will be evident that including these additional components may expand the spectrum of weeds controlled beyond the spectrum controlled by the compound of Formula 1 alone.

In certain instances, combinations of a compound of this invention with other biologically active (particularly herbicidal) compounds or agents (i.e. active ingredients) can result in a greater-than-additive (i.e. synergistic) effect on weeds and/or a less-than-additive effect (i.e. safening) on crops or other desirable plants. Reducing the quantity of active ingredients released in the environment while ensuring effective pest control is always desirable. Ability to use greater amounts of active ingredients to provide more effective weed control without excessive crop injury is also desirable. When synergism of herbicidal active ingredients occurs on weeds at application rates giving agronomically satisfactory levels of weed control, such combinations can be advantageous for reducing crop production cost and decreasing environmental load. When safening of herbicidal active ingredients occurs on crops, such combinations can be advantageous for increasing crop protection by reducing weed competition.

Of note is a combination of a compound of the invention with at least one other herbicidal active ingredient. Of particular note is such a combination where the other herbicidal active ingredient has different site of action from the compound of the invention. In certain instances, a combination with at least one other herbicidal active ingredient having a similar spectrum of control but a different site of action will be particularly advantageous for resistance management. Thus, a composition of the present invention can further comprise (in a herbicidally effective amount) at least one additional herbicidal active ingredient having a similar spectrum of control but a different site of action.

Compounds of this invention can also be used in combination with herbicide safeners such as allidochlor, N-(aminocarbonyl)-2-methylbenzenesulfonamide, benoxacor, BCS (1-bromo-4-[(chloromethyl)sulfonyl]benzene), cloquintocet-mexyl, cyometrinil, cyprosulfonamide, dichlormid, 4-(dichloroacetyl)-1-oxa-4-azospiro[4.5]decane (MON 4660), 2-(dichloromethyl)-2-methyl-1,3-dioxolane (MG 191), dicyclonon, dietholate, ethyl 1,6-dihydro-1-(2-methoxyphenyl)-6-oxo-2-phenyl-5-pyrimidinecarboxylate, fenchlorazole-ethyl, fenclorim, flurazole, fluxofenim, furilazole, 2-hydroxy-N,N-dimethyl-6-(trifluoromethyl)pyridine-3-carboxamide, isoxadifen-ethyl, mefenpyr-diethyl, mephenate, methoxyphenone ((4-methoxy-3-methylphenyl)(3-methylphenyl)methanone), naphthalic anhydride (1,8-naphthalic anhydride) oxabetrinil and 3-oxo-1-cyclohexen-1-yl 1-(3,4-dimethylphenyl)-1,6-dihydro-6-oxo-2-phenyl-5-pyrimidinecarboxylate to increase safety to certain crops. Antidotally effective amounts of the herbicide safeners can be applied at the same time as the compounds of this invention, or applied as seed treatments. Therefore an aspect of the present invention relates to a herbicidal mixture comprising a compound of this invention and an antidotally effective amount of a herbicide safener. Seed treatment is particularly useful for selective weed control, because it physically restricts antidoting to the crop plants. Therefore a particularly useful embodiment of the present invention is a method for selectively controlling the growth of undesired vegetation in a crop comprising contacting the locus of the crop with a herbicidally effective amount of a compound of this invention wherein seed from which the crop is grown is treated with an antidotally effective amount of safener. Antidotally effective amounts of safeners can be easily determined by one skilled in the art through simple experimentation.

Of note is a composition comprising a compound of the invention (in a herbicidally effective amount), at least one additional active ingredient selected from the group consisting of other herbicides and herbicide safeners (in an effective amount), and at least one component selected from the group consisting of surfactants, solid diluents and liquid diluents.

Preferred for better control of undesired vegetation (e.g., lower use rate such as from synergism, broader spectrum of weeds controlled, or enhanced crop safety) or for preventing the development of resistant weeds are mixtures of a compound of this invention with another herbicide. Table A1 lists specific combinations of a Component (a) with Component (b) illustrative of the mixtures, compositions and methods of the present invention. Compound 1 in the Component (a) column is identified in Index Table A. The second column of Table A1 lists the specific Component (b) compound (e.g., "2,4-D" in the first line). The third, fourth and fifth columns of Table A1 lists ranges of weight ratios for rates at which the Component (a) compound is typically applied to a field-grown crop relative to Component (b) (i.e. (a):(b)). Thus, for example, the first line of Table A1 specifically discloses the combination of Component (a) (i.e. Compound 1 in Index Table A) with 2,4-D is typically applied in a weight ratio between 1:192 to 6:1. The remaining lines of Table A1 are to be construed similarly.

TABLE A1

Component (a)	Component (b)	Typical Weight Ratio	More Typical Weight Ratio	Most Typical Weight Ratio
Compound 129	2,4-D	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-2-pyridinecarboxylic acid (halauxifen)	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-2-pyridinecarboxylic acid methyl ester (halauxifen methyl)	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	Acetochlor	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Acifluorfen	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Aclonifen	1:857 to 2:1	1:285 to 1:3	1:107 to 1:12
Compound 129	Alachlor	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Ametryn	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Amicarbazone	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Amidosulfuron	1:6 to 168:1	1:2 to 56:1	1:1 to 11:1
Compound 129	Aminocyclopyrachlor	1:48 to 24:1	1:16 to 8:1	1:6 to 2:1
Compound 129	Aminopyralid	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	Amitrole	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Anilofos	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Asulam	1:960 to 2:1	1:320 to 1:3	1:120 to 1:14
Compound 129	Atrazine	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Azimsulfuron	1:6 to 168:1	1:2 to 56:1	1:1 to 11:1
Compound 129	Beflubutamid	1:342 to 4:1	1:114 to 2:1	1:42 to 1:5
Compound 129	Benfuresate	1:617 to 2:1	1:205 to 1:2	1:77 to 1:9
Compound 129	Bensulfuron-methyl	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Bentazone	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Benzobicyclon	1:85 to 14:1	1:28 to 5:1	1:10 to 1:2
Compound 129	Benzofenap	1:257 to 5:1	1:85 to 2:1	1:32 to 1:4
Compound 129	Bicyclopyrone	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Bifenox	1:257 to 5:1	1:85 to 2:1	1:32 to 1:4
Compound 129	Bispyribac-sodium	1:10 to 112:1	1:3 to 38:1	1:1 to 7:1
Compound 129	Bromacil	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Bromobutide	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Bromoxynil	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Butachlor	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Butafenacil	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Butylate	1:1542 to 1:2	1:514 to 1:5	1:192 to 1:22
Compound 129	Carfenstrole	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Carfentrazone-ethyl	1:128 to 9:1	1:42 to 3:1	1:16 to 1:2
Compound 129	Chlorimuron-ethyl	1:8 to 135:1	1:2 to 45:1	1:1 to 9:1
Compound 129	Chlorotoluron	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Chlorsulfuron	1:6 to 168:1	1:2 to 56:1	1:1 to 11:1
Compound 129	Cincosulfuron	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Cinidon-ethyl	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Cinmethylin	1:34 to 34:1	1:11 to 12:1	1:4 to 3:1
Compound 129	Clacyfos	1:34 to 34:1	1:11 to 12:1	1:4 to 3:1
Compound 129	Clethodim	1:48 to 24:1	1:16 to 8:1	1:6 to 2:1
Compound 129	Clodinafop-propargyl	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	Clomazone	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Clomeprop	1:171 to 7:1	1:57 to 3:1	1:21 to 1:3
Compound 129	Clopyralid	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Cloransulam-methyl	1:12 to 96:1	1:4 to 32:1	1:1 to 6:1
Compound 129	Cumyluron	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Cyanazine	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Cyclopyrimorate	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Cyclosulfamuron	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Cycloxydim	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Cyhalofop	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Daimuron	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Desmedipham	1:322 to 4:1	1:107 to 2:1	1:40 to 1:5
Compound 129	Dicamba	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Dichlobenil	1:1371 to 1:2	1:457 to 1:4	1:171 to 1:20
Compound 129	Dichlorprop	1:925 to 2:1	1:308 to 1:3	1:115 to 1:13
Compound 129	Diclofop-methyl	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Diclosulam	1:10 to 112:1	1:3 to 38:1	1:1 to 7:1
Compound 129	Difenzoquat	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Diflufenican	1:857 to 2:1	1:285 to 1:3	1:107 to 1:12
Compound 129	Diflufenzopyr	1:12 to 96:1	1:4 to 32:1	1:1 to 6:1
Compound 129	Dimethachlor	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Dimethametryn	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Dimethenamid-P	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6

TABLE A1-continued

Component (a)	Component (b)	Typical Weight Ratio	More Typical Weight Ratio	Most Typical Weight Ratio
Compound 129	Dithiopyr	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Diuron	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	EPTC	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Esprocarb	1:1371 to 1:2	1:457 to 1:4	1:171 to 1:20
Compound 129	Ethalfluralin	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Ethametsulfuron-methyl	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Ethoxyfen	1:8 to 135:1	1:2 to 45:1	1:1 to 9:1
Compound 129	Ethoxysulfuron	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	Etobenzanid	1:257 to 5:1	1:85 to 2:1	1:32 to 1:4
Compound 129	Fenoxaprop-ethyl	1:120 to 10:1	1:40 to 4:1	1:15 to 1:2
Compound 129	Fenoxasulfone	1:85 to 14:1	1:28 to 5:1	1:10 to 1:2
Compound 129	Fenquinotrione	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Fentrazamide	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Flazasulfuron	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Florasulam	1:2 to 420:1	1:1 to 140:1	2:1 to 27:1
Compound 129	Fluazifop-butyl	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Flucarbazone	1:8 to 135:1	1:2 to 45:1	1:1 to 9:1
Compound 129	Flucetosulfuron	1:8 to 135:1	1:2 to 45:1	1:1 to 9:1
Compound 129	Flufenacet	1:257 to 5:1	1:85 to 2:1	1:32 to 1:4
Compound 129	Flumetsulam	1:24 to 48:1	1:8 to 16:1	1:3 to 3:1
Compound 129	Flumiclorac-pentyl	1:10 to 112:1	1:3 to 38:1	1:1 to 7:1
Compound 129	Flumioxazin	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Fluometuron	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Flupyrsulfuron-methyl	1:3 to 336:1	1:1 to 112:1	2:1 to 21:1
Compound 129	Fluridone	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Fluroxypyr	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Flurtamone	1:857 to 2:1	1:285 to 1:3	1:107 to 1:12
Compound 129	Fluthiacet-methyl	1:48 to 42:1	1:16 to 14:1	1:3 to 3:1
Compound 129	Fomesafen	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Foramsulfuron	1:13 to 84:1	1:4 to 28:1	1:1 to 6:1
Compound 129	Glufosinate	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Glyphosate	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Halosulfuron-methyl	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Haloxyfop-methyl	1:34 to 34:1	1:11 to 12:1	1:4 to 3:1
Compound 129	Hexazinone	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Imazamox	1:13 to 84:1	1:4 to 28:1	1:1 to 6:1
Compound 129	Imazapic	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	Imazapyr	1:85 to 14:1	1:28 to 5:1	1:10 to 1:2
Compound 129	Imazaquin	1:34 to 34:1	1:11 to 12:1	1:4 to 3:1
Compound 129	Imazethabenz-methyl	1:171 to 7:1	1:57 to 3:1	1:21 to 1:3
Compound 129	Imazethapyr	1:24 to 48:1	1:8 to 16:1	1:3 to 3:1
Compound 129	Imazosulfuron	1:27 to 42:1	1:9 to 14:1	1:3 to 3:1
Compound 129	Indanofan	1:342 to 4:1	1:114 to 2:1	1:42 to 1:5
Compound 129	Indaziflam	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Iodosulfuron-methyl	1:3 to 336:1	1:1 to 112:1	2:1 to 21:1
Compound 129	Ioxynil	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Ipfencarbazone	1:85 to 14:1	1:28 to 5:1	1:10 to 1:2
Compound 129	Isoproturon	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Isoxaben	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Isoxaflutole	1:60 to 20:1	1:20 to 7:1	1:7 to 2:1
Compound 129	Lactofen	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Lenacil	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Linuron	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	MCPA	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	MCPB	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Mecoprop	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Mefenacet	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Mefluidide	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Mesosulfuron-methyl	1:5 to 224:1	1:1 to 75:1	1:1 to 14:1
Compound 129	Mesotrione	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Metamifop	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Metazachlor	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Metazosulfuron	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Methabenzthiazuron	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Metolachlor	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Metosulam	1:8 to 135:1	1:2 to 45:1	1:1 to 9:1
Compound 129	Metribuzin	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Metsulfuron-methyl	1:2 to 560:1	1:1 to 187:1	3:1 to 35:1
Compound 129	Molinate	1:1028 to 2:1	1:342 to 1:3	1:128 to 1:15
Compound 129	Napropamide	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Naptalam	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Nicosulfuron	1:12 to 96:1	1:4 to 32:1	1:1 to 6:1
Compound 129	Norflurazon	1:1152 to 1:1	1:384 to 1:3	1:144 to 1:16
Compound 129	Orbencarb	1:1371 to 1:2	1:457 to 1:4	1:171 to 1:20
Compound 129	Orthosulfamuron	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	Oryzalin	1:514 to 3:1	1:171 to 1:2	1:64 to 1:8
Compound 129	Oxadiargyl	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6

TABLE A1-continued

Component (a)	Component (b)	Typical Weight Ratio	More Typical Weight Ratio	Most Typical Weight Ratio
Compound 129	Oxadiazon	1:548 to 3:1	1:182 to 1:2	1:68 to 1:8
Compound 129	Oxasulfuron	1:27 to 42:1	1:9 to 14:1	1:3 to 3:1
Compound 129	Oxaziclomefone	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Oxyfluorfen	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Paraquat	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Pendimethalin	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Penoxsulam	1:10 to 112:1	1:3 to 38:1	1:1 to 7:1
Compound 129	Penthoxamid	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Pentoxazone	1:102 to 12:1	1:34 to 4:1	1:12 to 1:2
Compound 129	Phenmedipham	1:102 to 12:1	1:34 to 4:1	1:12 to 1:2
Compound 129	Picloram	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Picolinafen	1:34 to 34:1	1:11 to 12:1	1:4 to 3:1
Compound 129	Pinoxaden	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Pretilachlor	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Primisulfuron-methyl	1:8 to 135:1	1:2 to 45:1	1:1 to 9:1
Compound 129	Prodiamine	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Profoxydim	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Prometryn	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Propachlor	1:1152 to 1:1	1:384 to 1:3	1:144 to 1:16
Compound 129	Propanil	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Propaquizafop	1:48 to 24:1	1:16 to 8:1	1:6 to 2:1
Compound 129	Propoxycarbazone	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Propyrisulfuron	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Propyzamide	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Prosulfocarb	1:1200 to 1:2	1:400 to 1:4	1:150 to 1:17
Compound 129	Prosulfuron	1:6 to 168:1	1:2 to 56:1	1:1 to 11:1
Compound 129	Pyraclonil	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Pyraflufen-ethyl	1:5 to 224:1	1:1 to 75:1	1:1 to 14:1
Compound 129	Pyrasulfotole	1:13 to 84:1	1:4 to 28:1	1:1 to 6:1
Compound 129	Pyrazolynate	1:857 to 2:1	1:285 to 1:3	1:107 to 1:12
Compound 129	Pyrazosulfuron-ethyl	1:10 to 112:1	1:3 to 38:1	1:1 to 7:1
Compound 129	Pyrazoxyfen	1:5 to 224:1	1:1 to 75:1	1:1 to 14:1
Compound 129	Pyribenzoxim	1:10 to 112:1	1:3 to 38:1	1:1 to 7:1
Compound 129	Pyributicarb	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Pyridate	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Pyriftalid	1:10 to 112:1	1:3 to 38:1	1:1 to 7:1
Compound 129	Pyriminobac-methyl	1:20 to 56:1	1:6 to 19:1	1:2 to 4:1
Compound 129	Pyrimisulfan	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Pyrithiobac	1:24 to 48:1	1:8 to 16:1	1:3 to 3:1
Compound 129	Pyroxasulfone	1:85 to 14:1	1:28 to 5:1	1:10 to 1:2
Compound 129	Pyroxsulam	1:5 to 224:1	1:1 to 75:1	1:1 to 14:1
Compound 129	Quinclorac	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Quizalofop-ethyl	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Rimsulfuron	1:13 to 84:1	1:4 to 28:1	1:1 to 6:1
Compound 129	Saflufenacil	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Sethoxydim	1:96 to 12:1	1:32 to 4:1	1:12 to 1:2
Compound 129	Simazine	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Sulcotrione	1:120 to 10:1	1:40 to 4:1	1:15 to 1:2
Compound 129	Sulfentrazone	1:147 to 8:1	1:49 to 3:1	1:18 to 1:3
Compound 129	Sulfometuron-methyl	1:34 to 34:1	1:11 to 12:1	1:4 to 3:1
Compound 129	Sulfosulfuron	1:8 to 135:1	1:2 to 45:1	1:1 to 9:1
Compound 129	Tebuthiuron	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Tefuryltrione	1:42 to 27:1	1:14 to 9:1	1:5 to 2:1
Compound 129	Tembotrione	1:31 to 37:1	1:10 to 13:1	1:3 to 3:1
Compound 129	Tepraloxydim	1:25 to 45:1	1:8 to 15:1	1:3 to 3:1
Compound 129	Terbacil	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Terbuthylatrazine	1:857 to 2:1	1:285 to 1:3	1:107 to 1:12
Compound 129	Terbutryn	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Thenylchlor	1:85 to 14:1	1:28 to 5:1	1:10 to 1:2
Compound 129	Thiazopyr	1:384 to 3:1	1:128 to 1:1	1:48 to 1:6
Compound 129	Thiencarbazone	1:3 to 336:1	1:1 to 112:1	2:1 to 21:1
Compound 129	Thifensulfuron-methyl	1:5 to 224:1	1:1 to 75:1	1:1 to 14:1
Compound 129	Tiafenacil	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Thiobencarb	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Topramazone	1:6 to 168:1	1:2 to 56:1	1:1 to 11:1
Compound 129	Tralkoxydim	1:68 to 17:1	1:22 to 6:1	1:8 to 2:1
Compound 129	Triallate	1:768 to 2:1	1:256 to 1:2	1:96 to 1:11
Compound 129	Triasulfuron	1:5 to 224:1	1:1 to 75:1	1:1 to 14:1
Compound 129	Triaziflam	1:171 to 7:1	1:57 to 3:1	1:21 to 1:3
Compound 129	Tribenuron-methyl	1:3 to 336:1	1:1 to 112:1	2:1 to 21:1
Compound 129	Triclopyr	1:192 to 6:1	1:64 to 2:1	1:24 to 1:3
Compound 129	Trifloxysulfuron	1:2 to 420:1	1:1 to 140:1	2:1 to 27:1
Compound 129	Trifluralin	1:288 to 4:1	1:96 to 2:1	1:36 to 1:4
Compound 129	Triflusulfuron-methyl	1:17 to 68:1	1:5 to 23:1	1:2 to 5:1
Compound 129	Tritosulfuron	1:13 to 84:1	1:4 to 28:1	1:1 to 6:1

Table A2 is constructed the same as Table A1 above except that entries below the "Component (a)" column heading are replaced with the respective Component (a) Column Entry shown below. Compound 2 in the Component (a) column is identified in Index Table A. Thus, for example, in Table A2 the entries below the "Component (a)" column heading all recite "Compound 2" (i.e. Compound 2 identified in Index Table A), and the first line below the column headings in Table A2 specifically discloses a mixture of Compound 2 with 2,4-D. Tables A3 and A4 are constructed similarly.

Table Number	Component (a) Column Entries
A2	Compound 14
A3	Compound 15
A4	Compound 16
A5	Compound 47
A6	Compound 129
A7	Compound 164
A8	Compound 196

Preferred for better control of undesired vegetation (e.g., lower use rate such as from synergism, broader spectrum of weeds controlled, or enhanced crop safety) or for preventing the development of resistant weeds are mixtures of a compound of this invention with a herbicide selected from the group glyphosate, chlorimuron-ethyl, nicosulfuron, mesotrione, thifensulfuron-methyl, flupyrsulfuron-methyl, tribenuron, pyroxasulfone. pinoxaden, tembotrione, florasulam, pyroxsulam, metolachlor and S-metolachlor.

The following Tests demonstrate the control efficacy of the compounds of this invention against specific weeds. The weed control afforded by the compounds is not limited, however, to these species. See Index Tables A-B for compound descriptions. The following abbreviations are used in the Index Tables which follow: t is tertiary, s is secondary, n is normal, i is iso, c is cyclo, Pr is propyl, Bu is butyl, c-Pr is cyclopropyl, t-Bu is tert-butyl, Ph is phenyl, thiene means thiophene, 4-pyridinyl(2-CF_3) corresponds to structure J-2A, and —NO_2 is nitro. The abbreviation "Ex." stands for "Example" and is followed by a number indicating in which example the compound is prepared.

INDEX TABLE A

Compd. No.	R^1	A	Q	J	M.P. (° C.) or M.S. (AP^+)
1 (Ex. 3)	CH_3	phenyl(4-CF_3)	O	3-thienyl(5-CF_3)	392 # **
2	CH_3	phenyl(4-F)	CH_2	1H-pyrazol-1-yl(3-CF_3)	40-42
3	CH_3	4-pyridinyl(2-F)	C═O	phenyl(3-CF_3)	351
4	CH_3	4-pyridinyl(2-Cl)	C═O	phenyl(3-CF_3)	367
5	CH_3	phenyl(2-Cl)	C═O	phenyl(3-CF_3)	366
6	CH_3	phenyl(2-SCH_3)	C═O	phenyl(3-CF_3)	378
7	CH_3	2-pyridinyl(5-CF_3)	CH_2	1H-pyrazol-1-yl(3-CF_3)	377
8	CH_3	2-pyridinyl(5-CF_3)	CH_2	1H-1,2,4-triazol-1-yl(3-CF_3)	378
9	CH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(2-Cl,4-CF_3)	119-121
10	CH_2CH_3	phenyl(4-F)	CH_2	1H-pyrazol-1-yl(3-CF_2CF_3)	*
11	CH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(2,5-di-Cl,4-CF_3)	118-120
12	CH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(3-CF_2CF_3)	54-57
13	CH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(5-Cl,4-CF_3)	124-126
14	OCH_2CF_3	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	471
15 (Ex. 1)	OCH_3	pheny(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	403 **
16	CH_3	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	337
17 (Ex. 2)	OCH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(3-	392 **
18	OCH_3	phenyl(4-CF_3)	CH_2	1H-1,2,4-triazol-1-yl(3-CF_3)	393
19	OCH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(3-CF_3)	392
20	CH_3	phenyl(4-F)	CH_2	1H-imidazol-1-yl(2,5-di-Cl,4-CF_3)	126-128
21	CH_3	2-pyridinyl(5-CF_3)	CH_2	1H-pyrazol-1-yl(3-CF_3,5-CH_3)	391
22	CH_3	4-pyridinyl	C═O	phenyl(3-CF_3)	333
23	CH_3	2-pyridinyl(5-CF_3)	O	4-pyridinyl(2-CF_3)	**
24	OCH_3	phenyl(4-F)	C═O	4-pyridinyl(2-CF_3)	367
25	$OCHF_2$	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	389
26	$OCHF_2$	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	439
27	SCH_3	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	369
28	Cl	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	407
29	OCH_3	phenyl(4-CF_3)	CH_2	phenyl(3-CF_3)	402
30	OCH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(3,5-di-CF_3)	*
31	CH_3	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-OCH_3)	*
32	CH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(4-CF_3)	*
33	CH_3	phenyl(4-F)	CH_2	4-pyridinyl(2-OCH_2CF_3)	367

INDEX TABLE A-continued

Compd. No.	R^1	A	Q	J	M.P. (° C.) or M.S. (AP^+)
34	OCH_3	phenyl(4-F)	O	4-pyridinyl(2-CF_3)	355
35	CH_3	phenyl(4-F)	CH_2	1H-imidazol-1-yl(2-Cl,4-CF_3)	124-126
36	CH_3	phenyl(4-F)	CH_2	1H-imidazol-1-yl(5-Cl,4-CF_3)	93-95
37	CH_3	phenyl(4-CF_3)	O	3-pyridinyl(5-CF_3)	389
38	CH_3	phenyl(3-CF_3)	O	4-pyrimidinyl(6-CF_3)	390
39	CH_3	2-pyridinyl(5-F)	C═O	phenyl(3-CF_3)	321
40	CH_3	phenyl(3-CF_3)	O	4-pyridinyl(2-CF_3)	389
41	CH_3	phenyl(4-NO_2)	C═O	phenyl(3-CF_3)	*
42	CH_3	phenyl(4-Cl)	C═O	phenyl(3-CF_3)	*
43	CH_3	phenyl	C═O	phenyl(3-CF_3)	332
44	CH_3	phenyl(4-CH_3)	C═O	phenyl(3-CF_3)	346
45	CH_3	phenyl(4-CF_3)	C═O	phenyl(3-CF_3)	*
47	CH_3	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	387
48	CH_3	phenyl(4-CF_3)	O	4-pyridinyl(2-$OCHF_2$)	387
49	CH_3	4-pyridinyl(2-CF_3)	C═O	phenyl(3-CF_3)	401
50	CH_3	5-pyrazinyl(2-Cl)	C═O	phenyl(3-CF_3)	368
51	CH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-4-yl(1-CH_2CF_3)	390
52	CH_3	phenyl(4-Cl)	O	4-pyridinyl(2-CF_3)	355
53	CH_3	phenyl(4-Br)	O	4-pyridinyl(2-CF_3)	400
54 (Ex. 10)	CH_3	phenyl(2,4-di-F)	CH_2	4-pyridinyl(2-CF_3)	355 **
55	CH_3	phenyl(3,4-di-F)	CH_2	4-pyridinyl(2-CF_3)	355
56	CH_3	phenyl(4-F)	O	phenyl(4-F,3-CF_3)	356
57	CH_3	2-pyridinyl(6-CF_3)	C═O	phenyl(3-CF_3)	400
58	CH_3	3-pyridazinyl(6-CF_3)	C═O	phenyl(CF_3)	*
59	CH_3	1H-1,2,4-thiadiazol-5-yl(3-Cl)	C═O	phenyl(3-CF_3)	374
60	CH_3	2-pyridinyl	C═O	phenyl(3-CF_3)	333
61	CH_3	phenyl(4-I)	C═O	phenyl(3-CF_3)	*
62	CH_3	phenyl(3-NO_2)	C═O	phenyl(3-CF_3)	
63	CH_3	phenyl(2-NO_2)	C═O	phenyl(3-CF_3)	
64	CH_3	phenyl(3-CF_3)	O	1H-pyrazol-5-yl(3-CF_3,1-CH_3)	392
65	CH_3	phenyl(2-Cl,4-F)	CH_2	4-pyridinyl(2-CF_3)	371
66	CH_3	3-pyridinyl(5-CF_3)	C═O	phenyl(3-CF_3)	401
68	CH_3	2-pyridinyl(5-CHF_2)	C═O	phenyl(3-CF_3)	383
69	CH_3	phenyl(4-CF_3)	NH	phenyl(3-CF_3)	101-104
70	CH_3	phenyl(3-CF_3)	O	phenyl(3-CF_3)	388
71	CH_3	phenyl(4-F)	O	4-pyridinyl(2-OCH_2CF_3)	369
72	CH_3	3-pyridinyl(6-Cl)	C═O	phenyl(3-CF_3)	367
73	CH_3	3-pyridinyl(6-CF_3)	C═O	phenyl(3-CF_3)	401
74	CH_3	phenyl(4-CF_3)	O	1H-pyrazol-4-yl(1-CH_2CF_3)	392
75	OCH_3	phenyl(4-CF_3)	C═O	4-pyridinyl(2-CF_3)	417
76	CH_3	phenyl(3-Cl)	C═O	phenyl(3-CF_3)	*
77	CH_3	phenyl(4-CF_3)	O	4-pyridinyl(2-OCH_2CF_3)	419
78	OCH_3	phenyl(4-CF_3)	CH(OH)	4-pyridinyl(2-CF_3)	*
79	OCH_3	phenyl(4-CF_3)	CCH_3(OH)	4-pyridinyl(2-CF_3)	*
80	OCH_3	phenyl(4-CF_3)	CHF	4-pyridinyl(2-CF_3)	421
82	CH_3	phenyl(4-CF_3)	O	phenyl(2-Cl)	354
83	CH_3	phenyl(4-CF_3)	O	phenyl(4-CF_3)	69-71
84	CH_3	phenyl(4-CF_3)	O	phenyl(3-Cl)	73-75
86	CH_3	phenyl(4-F)	O	phenyl(4-F,3-CH_3)	302
87	CH_3	phenyl(4-F)	O	4-pyridinyl(3-CH_3)	285
88	CH_3	phenyl(4-CF_3)	S	phenyl(3-CF_3)	404
90	CH_3	phenyl(3-I)	C═O	phenyl(3-CF_3)	*
91	CH_3	phenyl(2-I)	C═O	phenyl(3-CF_3)	*
92	CH_3	phenyl(4-Br)	C═O	phenyl(3-CF_3)	*
93	CH_3	phenyl(4-SCH_3)	C═O	phenyl(3-CF_3)	378
94	CH_3	phenyl(4-F)	CH_2	1H-1,2,4-triazol-1-yl(3-CF_3)	327
95	CH_3	phenyl(4-F)	CH_2	1H-pyrazol-1-yl(3-CF_3)	83-85
96	CH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(4-CF_3)	106-109
97	CH_3	phenyl(4-F)	CH_2	1H-pyrazol-1-yl(3-CF_3,5-CH_3)	91-93
98	CH_3	phenyl(4-F)	O	phenyl(3-CF_3)	*
99	CH_3	phenyl(4-F)	O	phenyl(4-Cl,3-CF_3)	*
100	CH_3	phenyl(4-F)	O	phenyl(3-OCF_3)	*
101	CH_3	phenyl(4-F)	O	4-pyrimidinyl(2-CF_3)	*
102	CH_3	phenyl(4-F)	O	2-pyrimidinyl(4-CF_3)	*

INDEX TABLE A-continued

Compd. No.	R^1	A	Q	J	M.P. (° C.) or M.S. (AP^+)
103	CH_3	phenyl(4-CF_3)	O	phenyl(4-Cl,3-CF_3)	*
104	CH_3	phenyl(4-CF_3)	O	1H-pyrazol-5-yl(1-CH_3,3-CF_3)	*
105	Br	2-pyridinyl(5-CF_3)	CH_2	phenyl(3-CF_3)	453
106	CH_3	2-pyridinyl(5-CF_3)	CH_2	phenyl(3-CF_3)	387
107	CH_3	2-pyridinyl(5-CF_3)	C═O	phenyl(3-CF_3)	401
108	CH_2CH_3	2-pyridinyl(5-CF_3)	CH_2	phenyl(3-CF_3)	*
109	CH_3	2-pyridinyl(5-CF_3)	O	phenyl(3-CF_3)	389
110	CH_2OH	phenyl(4-CF_3)	O	phenyl(3-CF_3)	*
111	CH_3	phenyl(4-CF3)	O	phenyl(3-CF_3)	*
112	CH_3	phenyl(4-F)	CH_2	1H-imidazol-1-yl(4-CF_3)	76-79
113	CH_2CH_3	phenyl(4-CF_3)	O	phenyl(3-CF_3)	*
114 (Ex. 5)	CH_2OH	phenyl(4-CF_3)	O	phenyl(3-OCF_3)	**
115 (Ex. 7)	CH_2OCH_3	phenyl(4-CF_3)	O	phenyl(3-OCF_3)	**
116 (Ex. 8)	CH_2F	phenyl(4-CF_3)	O	phenyl(3-OCF_3)	**
117	CH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(3-CF_3)	60-63
118	CH_2CH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(3-CF_3)	390
119 (Ex. 6)	CH_3	phenyl(4-CF_3)	O	phenyl(3-OCF_3)	**
120	CH_3	phenyl(4-CF_3)	O	4-pyridinyl(2-CF_3)	78.3-78.8
121	CH_2CH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(5-Cl,4-CF_3)	98-100
122	CH_2CH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(2-Cl,4-CF_3)	82-84
123	Br	phenyl(4-CF_3)	CH_2	phenyl(3-CF_3)	*
124	CH_3	phenyl(4-CF_3)	CH_2	phenyl(3-CF_3)	*
125 (Ex. 9)	CH_2CH_3	phenyl(4-CF_3)	O	phenyl(3-OCF_3)	**
126	CH_3	phenyl(4-F)	O	1H-pyrazol-5-yl(3-CF_3,1-CH_3)	342
127	CH_3	phenyl(4-F)	O	2-pyridinyl(6-CF_3)	*
128	CH_3	phenyl(4-F)	O	2-pyridinyl(4-CF_3)	*
129 (Ex. 4)	CH_3	phenyl(4-F)	O	4-pyridinyl(2-CF_3)	43.5-44.1
130	CH_2CH_3	phenyl(4-CF_3)	CH_2	1H-1,2,4-triazol-1-yl(3-CF_3)	391
131	CH_2CH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(3-CF_3,5-CH_3)	74-76
132	CH_3	phenyl(4-CF_3)	CH_2	1H-1,2,4-triazol-1-yl(3-CF_3)	377
133	CH_2CH_3	phenyl(4-CF_3)	CH_2	1H-imidazol-1-yl(4-CF_3)	84-86
134	CH_3	phenyl(4-CF_3)	CH_2	1H-pyrazol-1-yl(3-CF_3,5-CH_3)	101-103
135	CH_3	phenyl(4-F)	O	4-pyridinyl(2-CH_3)	285
136	CH_3	phenyl(3,4-di-F)	CH_2	4-pyridinyl(2-CHF_2)	337, 335 #
137	CH_3	4-pyridinyl(2-CF_3)	CH_2	4-pyridinyl(2-CF_3)	386 #
138	OCH_3	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CHF_2)	385, 383 #
139	OCH_3	phenyl(5-F)	CH_2	4-pyridinyl(2-CF_3)	353
140	CH_3	4-pyridinyl(2-CF_3)	C═N—OMe	phenyl(3-CF_3)	430
141	CH_3	4-pyridinyl(2-Cl)	CH_2	4-pyridinyl(2-CF_3)	354, 352 #
142	OCH_2CF_3	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	421
143	CH_2CH_3	phenyl(3-CF_3)	CH_2	phenyl(3-CF_3)	44-46
144	CH_2CH_3	phenyl(4-F)	CH_2	phenyl(3-CF_3)	45-47
145	CH_3	phenyl(3,4-di-F)	O	4-pyridinyl(2-CF_3)	357
146	CH_3	phenyl(2,4-di-F)	O	4-pyridinyl(2-CF_3)	357
147	CH_3	phenyl(4-F,3-CF_3)	O	4-pyridinyl(2-CF_3)	407
148	CH_3	phenyl(3-F,4-CF_3)	O	4-pyridinyl(2-CF_3)	407
149	n-Pr	phenyl(4-F)	CH_2	phenyl(3-CF_3)	59-62
150	$CH(CH_3)_2$	phenyl(4-F)	CH_2	phenyl(3-CF_3)	364
151	$CH(CH_3)_2$	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	365
152	OCH_3	phenyl(4-F)	$CH(CH_3)$	4-pyridinyl(2-CF_3)	418
153	n-Pr	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	365
154	CH_2CH_3	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	351
155	CH_2CH_3	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	401
156	CH_3	phenyl(4-F,3-CF_3)	CH_2	4-pyridinyl(2-CF_3)	405
157	CH_3	phenyl(4-F)	CH_2	phenyl(3-CF_3)	336
158	F	phenyl(4-F)	C═O	4-pyridinyl(2-CF_3)	*
159	F	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	*
160	CH_2F	phenyl(4-F)	O	4-pyridinyl(2-CF_3)	*
161	CH_2OCH_3	phenyl(4-F)	O	4-pyridinyl(2-CF_3)	*
162	CH_3	phenyl(3-F,4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	405
163	$CH_2OCH_2CH_3$	phenyl(4-F)	O	4-pyridinyl(2-CF_3)	*
164	OCH_2CH_3	phenyl(3-CF_3)	CH_2	4-pyridinyl(2-CF_3)	*
165	OCH_3	phenyl(2,4-di-F)	CH_2	4-pyridinyl(2-CF_3)	371
166	CH_2CH_3	phenyl(4-F)	O	4-pyridinyl(2-CF_3)	*
167	CH_3	phenyl(4-F)	C═O	4-pyridinyl(2-CF_3)	*

INDEX TABLE A-continued

Compd. No.	R^1	A	Q	J	M.P. (° C.) or M.S. (AP^+)
168	n-Pr	phenyl(4-F)	O	4-pyridinyl(2-CF_3)	*
169	CH_2CH_3	phenyl(4-CF_3)	O	4-pyridinyl(2-CF_3)	*
170	n-Pr	phenyl(4-CF_3)	O	4-pyridinyl(2-CF_3)	417
171	CH_2CH_3	phenyl(3,4-di-F)	O	4-pyridinyl(2-CF_3)	371
172	n-Pr	phenyl(3,4-di-F)	O	4-pyridinyl(2-CF_3)	385
173	CH_2CH_3	phenyl(3,4-di-F)	O	4-pyridinyl(2-CH_2F)	353
174	n-Pr	phenyl(3,4-di-F)	O	4-pyridinyl(2-CH_2F)	367
175	t-Bu	phenyl(4-F)	C═O	4-pyridinyl(2-CF_3)	*
176	t-Bu	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	*
177	OCH_2CH_3	phenyl(4-F)	C═O	4-pyridinyl(2-CF_3)	*
178	CH_2CH_3	phenyl(2,4-di-F)	O	4-pyridinyl(2-CF_3)	371
179	n-Pr	phenyl(2,4-di-F)	O	4-pyridinyl(2-CF_3)	385
180	CH_2CH_3	phenyl(4-F,3-CF_3)	O	4-pyridinyl(2-CF_3)	421
181	CH_2CH_3	phenyl(2,4-di-F)	O	4-pyridinyl(2-CHF_2)	353
182	n-Pr	phenyl	O	4-pyridinyl(2-CHF_2)	367
183	CH2CH3	phenyl(3-F,4-CF_3)	O	4-pyridinyl(2-CF_3)	421
184	n-Bu	phenyl(4-CF3)	O	4-pyridinyl(2-CF_3)	*
185	n-Pr	phenyl(3-F,4-CF_3)	O	4-pyridinyl(2-CF_3)	*
186	$CH_2CH(CH_3)_2$	phenyl(4-CF_3)	O	4-pyridinyl(2-CF_3)	431
187	$CH_2CH(CH3)_2$	phenyl(4-CF_3)	O	4-pyridinyl(2-CHF_2)	413
188	OCH_2CH_3	phenyl(4-Cl)	CH_2	4-pyridinyl(2-CF_3)	*
189	OCH_2CH_3	phenyl(4-Br)	CH_2	4-pyridinyl(2-CF_3)	*
190	OCH_2CH_3	phenyl(2,4-di-F)	CH_2	4-pyridinyl(2-CF_3)	*
191	O-n-Pr	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	*
192	$OCH(CH_3)_2$	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	*
193	$OCH_2CH(CH_3)_2$	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	*
194	O-n-Bu	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	*
195	OCH_2CH_3	phenyl(4-F)	CH_2	4-pyridinyl(2-CHF_2)	*
196 (Ex. 11)	OCH_2CH_3	phenyl(4-F)	CH_2	4-pyridinyl(2-CF_3)	59-60
197	$OC(═O)CH_3$	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	*
198	OH	phenyl(4-CF_3)	CH_2	4-pyridinyl(2-CF_3)	389
199	c-Pr	phenyl(3-CF_3)	O	4-pyridinyl(2-CF_3)	397
200	c-Pr	phenyl(3-CF_3)	O	4-pyridinyl(2-CF_3)	415
201	CH_3	2-pyridinyl(5-CF_3)	C═N—OH	phenyl(3-CF_3)	416

* See Index Table B for ^{1}H NMR data.

** See Synthesis Example for ^{1}H NMR data.

reported as AP^-.

INDEX TABLE B

Compd. No.	^{1}H NMR data[a]
10	1.21 (t, 3H), 2.70 (q, 2H), 5.53 (s, 2H), 6.55 (d, 1H), 7.55 (t, 1H), 7.73 (d, 2H), 8.15 (d, 2H)
23	2.42 (s, 3H), 7.39 (m, 1H), 7.57 (m, 1H), 8.06 (m, 1H), 8.13 (m, 1H), 8.69 (m, 1H), 8.84 (s, 1H)
30	4.04 (s, 3H), 5.55 (s, 2H), 6.93 (s, 1H), 7.66-7.71 (m, 2H), 8.00-8.04 (m, 2H)
31	2.26 (s, 3H), 3.92 (s, 3H), 4.02 (s, 2H), 6.58-6.61 (m, 1H), 6.75-6.79 (m, 1H), 7.69-7.73 (m, 2H), 8.07-8.14 (m, 3H)
32	2.36 (s, 3H), 5.46 (s, 2H), 7.72-7.75 (m, 3H), 7.77 (s, 1H), 8.12-8.16 (m, 2H)
41	2.73 (s, 3H), 7.67-7.73 (m, 1H), 7.89-7.93 (m, 1H), 8.25-8.30 (m, 2H), 8.37-8.42 (m, 2H), 8.46-8.50 (m, 1H), 8.60-8.63 (m, 1H)
42	2.71 (s, 3H), 7.47-7.51 (m, 2H), 7.65-7.70 (m, 1H), 7.86-7.91 (m, 1H), 8.03-8.07 (m, 2H), 8.46-8.50 (m, 1H), 8.61-8.64 (m, 1H)
45	2.73 (s, 3H), 7.66-7.72 (m, 1H), 7.77-7.82 (m, 2H), 7.88-7.92 (m, 1H), 8.22-8.26 (m, 2H), 8.47-8.50 (m, 1H), 8.63-8.65 (m, 1H)
58	2.80 (s, 3H), 7.68-7.73 (m, 1H), 7.89-7.93 (m, 1H), 8.04-8.08 (m, 1H), 8.42-8.45 (m, 1H), 8.55-8.59 (m, 2H)
61	2.71 (s, 3H), 7.64-7.69 (m, 1H), 7.82-7.90 (m, 5H), 8.45-8.49 (m, 1H), 8.61-8.64 (m, 1H)
62	2.74 (s, 3H), 7.68-7.75 (m, 2H), 7.89-7.93 (m, 1H), 8.25-8.29 (m, 1H), 8.42-8.51 (m, 2H), 8.61-8.64 (m, 1H), 8.96-8.98 (m, 1H)
63	2.71 (s, 3H), 7.58-7.69 (m, 2H), 7.72-7.77 (m, 1H), 7.83-7.90 (m, 2H), 7.95-7.99 (m, 1H), 8.37-8.41 (m, 1H), 8.45-8.48 (m, 1H)
76	2.71 (s, 3H), 7.36-7.47 (m, 2H), 7.66-7.71 (m, 1H), 7.86-7.91 (m, 1H), 7.97-8.01 (m, 1H), 8.12-8.16 (m, 1H), 8.47-8.51 (m, 1H), 8.61-8.63 (m, 1H)
78	2.89-2.91 (m, 1H), 4.07 (s, 3H), 6.07-6.10 (m, 1H), 7.60-7.63 (m, 1H), 7.68-7.72 (m, 2H), 7.85-7.87 (m, 1H), 8.00-8.04 (m, 2H), 8.72-8.75 (m, 1H)
79	1.54 (s, 3H), 3.38 (s, 1H), 4.05 (s, 3H), 7.58-7.62 (m, 1H), 7.69-7.73 (m, 2H), 7.87-7.89 (m, 1H), 8.02-8.06 (m, 2H), 8.68-8.70 (m, 1H)
90	2.71 (s, 3H), 7.22-7.27 (m, 1H), 7.66-7.77 (m, 2H), 7.88-7.91 (m, 1H), 8.05-8.09 (m, 1H), 8.46-8.50 (m, 2H), 8.61-8.64 (m, 1H)
91	2.74 (s, 3H), 7.21-7.26 (m, 1H), 7.48-7.67 (m, 3H), 7.83-7.87 (m, 1H), 8.02-8.06 (m, 1H), 8.55-8.59 (m, 1H), 8.65-8.68 (m, 1H)
92	2.71 (s, 3H), 7.62-7.70 (m, 3H), 7.86-7.91 (m, 1H), 7.96-8.01 (m, 2H), 8.46-8.50 (m, 1H), 8.61-8.64 (m, 1H)

INDEX TABLE B-continued

Compd. No.	^{1}H NMR data[a]
98	2.29 (s, 3H), 7.14 (m, 2H), 7.42 (m, 4H), 7.91 (m, 2H)
99	2.31 (s, 3H), 7.13 (m, 2H), 7.33 (m, 1H), 7.49 (m, 1H), 7.57 (m, 1H), 7.90 (m, 2H)
100	2.29 (s, 3H), 7.02 (m, 1H), 7.13 (m, 3H), 7.33 (m, 1H), 7.92 (m, 2H)
101	2.28 (s, 3H), 7.16 (m, 2H), 7.30 (m, 1H), 7.94 (m, 2H), 8.84 (m, 1H)
102	2.27 (s, 3H), 7.15 (m, 2H), 7.47 (m, 1H), 7.95 (m, 2H), 8.82 (m, 1H)
103	2.34 (s, 3H), 7.35-7.39 (m, 1H), 7.49-7.53 (m, 1H), 7.59-7.62 (m, 1H), 7.68-7.73 (m, 2H), 8.01-8.05 (m, 2H)
104	2.38 (m, 3H), 3.89-3.91 (m, 3H), 6.73-6.74 (m, 1H), 7.89-7.94 (m, 2H), 8.09-8.13 (m, 2H) (dmso d_6)
108	1.18-1.24 (m, 3H), 2.60-2.66 (m, 2H), 4.21 (s, 2H), 7.40-7.54 (m, 4H), 8.05-8.16 (m, 2H), 8.80-8.85 (m, 1H)
110	1.96 (br s, 1H), 4.81-4.85 (m, 2H), 7.44-7.58 (m, 4H), 7.70-7.74 (m, 2H), 8.04-8.08 (m, 2H)
111	2.33 (s, 3H), 7.39-7.53 (m, 4H), 7.68-7.72 (m, 2H), 8.02-8.06 (m, 2H)
113	1.30-1.35 (m, 3H), 2.69-2.75 (m, 2H), 7.39-7.53 (m, 4H), 7.68-7.72 (m, 2H), 8.03-8.07 (m, 2H)
123	4.16 (s, 2H), 7.42-7.60 (m, 3H), 7.72-7.76 (m, 2H), 8.12-8.16 (m, 2H)
124	2.25 (s, 3H), 4.14 (s, 2H), 7.42-7.53 (m, 3H), 7.69-7.73 (m, 2H), 8.10-8.14 (m, 2H)
127	2.25 (s, 3H), 7.14 (m, 2H), 7.30 (m, 2H), 7.58 (m, 1H), 7.95 (m, 3H)
128	2.25 (s, 3H), 7.14 (m, 2H), 7.29 (m, 1H), 7.34 (s, 1H), 7.93 (m, 2H), 8.33 (m, 1H)
158	7.23-7.29 (m, 2H), 8.02-8.06 (m, 2H), 8.31-8.33 (m, 1H), 8.51-8.53 (m, 1H), 9.01-9.04 (m, 1H)
159	4.16 (s, 2H), 7.13-7.19 (m, 2H), 7.43-7.46 (m, 1H), 7.63-7.66 (m, 1H), 7.87-7.94 (m, 2H), 8.67-8.71 (m, 1H)
160	5.43-5.56 (m, 2H), 7.17-7.23 (m, 2H), 7.37-7.42 (m, 1H), 7.59-7.62 (m, 1H), 7.95-8.02 (m, 2H), 8.68-8.72 (m, 1H)
161	3.40 (s, 3H), 4.55 (s, 2H), 7.14-7.21 (m, 2H), 7.33-7.36 (m, 1H), 7.54-7.57 (m, 1H), 7.95-8.00 (m, 2H), 8.66-8.70 (m, 1H)
163	1.13-1.18 (m, 3H), 3.53-3.59 (m, 2H), 4.59 (s, 2H), 7.15-7.21 (m, 2H), 7.32-7.35 (m, 1H), 7.52-7.55 (m, 1H), 7.95-8.00 (m, 2H), 8.66-8.70 (m, 1H)
164	1.40-1.45 (m, 3H), 4.10 (s, 2H), 4.36-4.40 (m, 2H), 7.43-7.46 (m, 1H), 7.66-7.70 (m, 3H), 7.99-8.02 (m, 2H), 8.64-8.67 (m, 1H)
166	1.29-1.35 (m, 3H), 2.66-2.75 (m, 2H), 7.13-7.20 (m, 2H), 7.28-7.32 (m, 1H), 7.51-7.53 (m, 1H), 7.91-7.98 (m, 2H), 8.65-8.68 (m, 1H)
167	2.73 (s, 3H), 7.24 (m, 2H), 8.15 (m, 1H), 8.31 (d, 1H), 8.51 (s, 1H), 9.00 (d, 1H)
168	0.97-1.00 (m, 3H), 1.79-1.69 (m, 2H), 2.63-2.68 (m, 2H), 7.13-7.20 (m, 2H), 7.28-7.32 (m, 1H), 7.51-7.53 (m, 1H), 7.91-7.98 (m, 2H), 8.65-8.68 (m, 1H)
169	1.31-1.37 (m, 3H), 2.71-2.77 (m, 2H), 7.34-7.37 (m, 1H), 7.54-7.57 (m, 1H), 7.72-7.76 (m, 2H), 8.07-8.11 (m, 2H), 8.68-8.71 (m, 1H)
175	1.53 (s, 9H), 7.24 (m, 2H), 8.00 (m, 2H), 8.10 (m, 1H), 8.35(s, 1H), 8.95 (m, 1H)
176	1.35 (s, 9H), 4.31 (s, 2H), 7.24(m, 2H), 7.35 (m, 1H), 7.61 (m, 1H), 8.00 (m, 2H), 8.65 (m, 1H)
177	1.53-1.58 (m, 3H), 4.54-4.60 (m, 2H), 7.18-7.25 (m, 2H), 7.99-8.06 (m, 2H), 8.23-8.26 (m, 1H), 8.45-8.47 (m, 1H), 8.95-8.98 (m, 1H)
184	0.92-0.97 (m, 3H), 1.36-1.45 (m, 2H), 1.67-1.75 (m, 2H), 2.68-2.73 (m, 2H), 7.34-7.37 (m, 1H), 7.54-7.57 (m, 1H), 7.72-7.76 (m, 2H), 8.11-8.07 (m, 2H), 8.68-8.71 (m, 1H)
185	0.99-1.04 (m, 3H), 1.72-1.81 (m, 2H), 2.65-2.72 (m, 2H), 7.35-7.39 (m, 1H), 7.55-7.57 (m, 1H), 7.68-7.73 (m, 1H), 7.81-7.87 (m, 2H), 8.69-8.72 (m, 1H)
188	1.39-1.44 (m, 3H), 4.08 (s, 2H), 4.32-4.40 (m, 2H), 7.36-7.41 (m, 2H), 7.41-7.45 (m, 1H), 7.66-7.68 (m, 1H), 7.81-7.86 (m, 2H), 8.63-8.66 (m, 1H)
189	1.38-1.44 (m, 3H), 4.08 (s, 2H), 4.32-4.40 (m, 2H), 7.42-7.45 (m, 1H), 7.51-7.57 (m, 2H), 7.66-7.68 (m, 1H), 7.75-7.81 (m, 2H), 8.63-8.66 (m, 1H)
190	1.38-1.43 (m, 3H), 4.10 (s, 2H), 4.32-4.38 (m, 2H), 6.94-7.03 (m, 2H), 7.65-7.72 (m, 2H), 7.43-7.46 (m, 1H), 8.63-8.66 (m, 1H)
191	0.97-1.02 (m, 3H), 1.77-1.87 (m, 2H), 4.11 (s, 2H), 4.26-4.30 (m, 2H), 7.43-7.47 (m, 1H), 7.65-7.71 (m, 3H), 7.99-8.03 (m, 2H), 8.64-8.67 (m, 1H)
192	1.37-1.40 (m, 6H), 4.09 (s, 2H), 4.93-5.01 (m, 1H), 7.43-7.46 (m, 1H), 7.66-7.70 (m, 3H), 7.98-8.02 (m, 2H), 8.63-8.66 (m, 1H)
193	0.95-0.99 (m, 6H), 2.05-2.14 (m, 1H), 4.07-4.10 (m, 2H), 4.11 (s, 2H), 7.43-7.47 (m, 1H), 7.66-7.70 (m, 3H), 7.99-8.03 (m, 2H), 8.64-8.67 (m, 1H)
194	0.94-0.99 (m, 3H), 1.37-1.47 (m, 2H), 1.73-1.80 (m, 2H), 4.10 (s, 2H), 4.30-4.34 (m, 2H), 7.42-7.46 (m, 1H), 7.64-7.71 (m, 3H), 7.99-8.02 (m, 2H), 8.63-8.66 (m, 1H)
195	1.38-1.44 (m, 3H), 4.06 (s, 2H), 4.32-4.40 (m, 2H), 6.50-6.74 (m, 1H), 7.07-7.15 (m, 2H), 7.33-7.37 (m, 1H), 7.61 (s, 1H), 7.83-7.90 (m, 2H), 8.54-8.57 (m, 1H)
197	2.28 (s, 3H), 4.11-4.13 (m, 2H), 7.38-7.41 (m, 1H), 7.60-7.63 (m, 1H), 7.72-7.76 (m, 2H), 8.06-8.10 (m, 2H), 8.67-8.70 (m, 1H)

[a]^{1}H NMRH data are in ppm downfield from tetramethylsilane, in $CDCl_3$ unless otherwise indicated. Couplings are designated by (s)-singlet, (d)-doublet, (t)-triplet, (m)-multiplet, (t)-triplet, (q)-quartet and (br s)-broad singlet.

BIOLOGICAL EXAMPLES OF THE INVENTION

Test A

Seeds of barnyardgrass (*Echinochloa crus-galli*), crabgrass, large (large crabgrass, *Digitaria sanguinalis*), foxtail, giant (giant foxtail, *Setaria faberii*), morningglory (*Ipomoea* spp.), pigweed (*Amaranthus retroflexus*), velvetleaf (*Abutilon theophrasti*), wheat (*Triticum aestivum*), and corn (*Zea mays*) were planted into a blend of loam soil and sand and treated preemergence with a directed soil spray using test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. At the same time these species were also treated with postemergence applications of test chemicals formulated in the same manner.

Plants ranged in height from two to ten cm and were in the one- to two-leaf stage for the postemergence treatment. Treated plants and untreated controls were maintained in a greenhouse for approximately ten days, after which time all treated plants were compared to untreated controls and visually evaluated for injury. Plant response ratings, summarized in Table A, are based on a 0 to 100 scale where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE A

Compounds

1000 g ai/ha	94	95	96	97	105	106	109	117	118	123	124	130	131	132
Postemergence														
Barnyardgrass	40	60	40	30	10	40	90	80	30	10	70	50	30	80
Corn	40	30	30	10	10	10	90	40	30	40	60	30	30	30
Crabgrass, Large	80	80	70	60	50	80	90	90	90	80	90	90	90	90
Foxtail, Giant	70	60	60	20	—	—	90	90	60	60	90	80	50	90
Morningglory	100	60	80	40	90	100	90	90	100	100	100	100	70	100
Pigweed	100	100	90	60	100	100	100	100	100	100	100	100	100	100
Velvetleaf	80	70	70	50	40	70	80	100	70	100	100	100	40	90
Wheat	30	0	30	0	0	10	50	20	20	20	40	30	0	30

	Compounds				Compound
1000 g ai/ha	133	134	167	31 g ai/ha	34
Postemergence					
Barnyardgrass	40	30	100	Barnyardgrass	0
Corn	20	20	30	Corn	10
Crabgrass, Large	80	90	100	Crabgrass, Large	10
Foxtail, Giant	70	50	100	Foxtail, Giant	10
Morningglory	90	100	100	Morningglory	20
Pigweed	100	100	100	Pigweed	20
Velvetleaf	90	50	50	Velvetleaf	0
Wheat	30	0	40	Wheat	0

Compounds

500 g ai/ha	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Postemergence														
Barnyardgrass	20	10	50	30	0	0	90	80	60	50	0	80	0	90
Corn	20	10	30	30	0	0	50	40	30	20	0	30	0	40
Crabgrass, Large	90	20	90	70	0	20	90	80	70	60	0	90	0	90
Foxtail, Giant	70	20	90	40	0	10	90	80	70	50	0	70	10	90
Morningglory	100	20	100	40	0	0	90	90	100	100	0	100	10	100
Pigweed	100	90	100	100	30	30	100	100	100	100	20	100	0	100
Velvetleaf	70	0	60	30	0	0	70	80	80	50	0	100	0	100
Wheat	20	10	40	40	0	0	20	20	20	10	0	30	0	50

Compounds

500 g ai/ha	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Postemergence														
Barnyardgrass	90	100	90	60	50	0	10	20	90	20	90	90	20	90
Corn	50	50	30	30	20	10	10	20	50	20	30	40	20	50
Crabgrass, Large	90	90	90	80	70	10	40	60	90	20	90	90	40	90
Foxtail, Giant	90	90	80	70	50	10	10	50	90	20	90	90	40	90
Morningglory	100	100	90	90	80	10	40	20	100	20	100	100	90	100
Pigweed	100	100	100	100	100	30	80	80	100	90	100	100	100	100

TABLE A-continued

	Compounds													
Velvetleaf	100	100	100	80	70	20	20	30	100	20	100	100	50	100
Wheat	50	30	40	30	30	0	0	—	50	10	60	80	40	50

	Compounds													
500 g ai/ha	29	30	31	32	33	35	36	37	38	39	40	41	42	43
Postemergence														
Barnyardgrass	40	0	10	10	0	90	0	20	0	10	40	10	10	20
Corn	20	0	20	10	10	50	0	20	0	10	30	20	10	30
Crabgrass, Large	90	0	50	30	10	90	0	70	50	10	90	30	30	40
Foxtail, Giant	90	0	50	20	10	90	0	80	0	10	90	20	20	30
Morningglory	100	0	100	50	10	100	0	90	0	0	100	10	50	40
Pigweed	100	0	90	100	50	100	20	100	30	50	100	80	90	70
Velvetleaf	80	0	20	20	0	100	10	50	60	0	100	50	20	20
Wheat	30	0	10	0	0	60	0	10	0	0	30	10	10	30

	Compounds													
500 g ai/ha	44	45	47	48	49	50	51	52	53	54	55	56	57	58
Postemergence														
Barnyardgrass	20	10	90	30	20	10	10	70	90	90	90	30	0	10
Corn	30	20	40	30	20	10	10	20	40	60	50	20	0	10
Crabgrass, Large	40	70	90	90	90	10	10	100	90	90	90	80	10	10
Foxtail, Giant	30	50	90	70	60	10	10	100	90	90	90	80	0	10
Morningglory	70	80	90	90	50	10	10	100	—	—	—	—	0	10
Pigweed	90	100	100	100	100	20	60	100	100	100	100	100	10	80
Velvetleaf	70	70	100	50	60	10	10	100	100	100	100	90	0	0
Wheat	30	20	50	20	20	0	0	20	30	30	40	20	0	10

	Compounds													
500 g ai/ha	59	60	61	62	63	64	65	66	68	69	70	71	72	73
Postemergence														
Barnyardgrass	0	10	10	10	0	0	40	10	10	10	10	10	10	30
Corn	0	10	10	0	0	0	20	10	10	20	20	10	10	20
Crabgrass, Large	0	10	10	0	0	0	50	10	10	20	30	10	10	60
Foxtail, Giant	0	0	10	0	0	0	70	10	10	10	20	10	10	40
Morningglory	0	0	30	0	0	0	—	10	10	30	20	10	10	70
Pigweed	0	10	80	10	10	0	100	30	50	90	100	40	70	100
Velvetleaf	0	0	30	0	0	0	60	10	0	20	50	10	10	40
Wheat	0	0	0	0	0	0	20	10	10	10	10	0	0	20

	Compounds													
500 g ai/ha	74	75	76	77	78	79	80	82	83	84	86	87	88	90
Postemergence														
Barnyardgrass	0	10	20	10	10	0	70	0	0	10	0	0	20	10
Corn	0	10	20	10	10	0	20	0	0	30	0	0	10	10
Crabgrass, Large	0	20	30	20	20	0	80	0	0	50	0	0	80	10
Foxtail, Giant	0	20	20	20	30	10	80	0	0	20	0	0	40	10
Morningglory	0	30	20	10	40	0	90	0	0	30	0	0	50	10
Pigweed	0	60	60	100	90	0	100	0	0	90	0	0	100	30
Velvetleaf	0	10	10	10	20	0	100	0	0	20	0	0	80	0
Wheat	0	0	20	0	0	0	40	0	0	0	0	0	10	0

	Compounds													
500 g ai/ha	91	92	93	98	99	100	101	102	103	104	107	108	110	111
Postemergence														
Barnyardgrass	10	10	10	80	30	30	60	0	0	30	60	70	30	30
Corn	10	10	10	30	20	20	20	0	0	20	30	30	30	30
Crabgrass, Large	10	30	20	90	70	80	90	10	30	70	90	90	70	90
Foxtail, Giant	10	20	10	90	80	70	90	0	20	50	90	90	30	90
Morningglory	0	30	10	100	80	90	40	0	0	90	80	100	100	100
Pigweed	30	90	20	100	100	90	90	70	70	100	100	100	100	90
Velvetleaf	10	20	20	80	60	70	20	0	10	60	50	80	60	70
Wheat	0	10	0	30	20	20	10	0	0	0	40	30	30	40

TABLE A-continued

Compounds													
	Compounds												
500 g ai/ha	112	114	115	116	119	120	121	122	125	126	127	128	129
Postemergence													
Barnyardgrass	30	30	30	20	20	80	0	70	30	70	20	20	90
Corn	20	30	30	30	30	50	10	30	30	30	20	10	40
Crabgrass, Large	90	70	80	80	70	90	10	90	90	90	30	20	90
Foxtail, Giant	80	40	60	50	60	80	0	90	60	90	20	10	90
Morningglory	100	90	100	100	70	100	0	100	100	80	30	30	100
Pigweed	100	90	100	100	100	100	20	100	100	100	60	40	100
Velvetleaf	60	50	30	50	40	80	10	100	70	80	20	30	100
Wheat	30	30	20	10	10	30	0	30	20	20	10	0	30

	Compounds													
500 g ai/ha	135	136	137	138	139	140	141	142	143	144	145	146	147	148
Postemergence														
Barnyardgrass	10	90	90	90	100	30	90	100	50	30	90	90	80	90
Corn	20	40	30	70	50	30	50	80	50	30	90	80	40	40
Crabgrass, Large	20	90	90	90	90	50	90	100	100	90	90	90	90	80
Foxtail, Giant	10	90	90	90	100	50	90	100	100	90	100	90	80	80
Morningglory	10	100	100	100	100	90	90	100	90	90	100	90	90	90
Pigweed	50	100	100	100	100	100	100	100	100	100	100	100	100	100
Velvetleaf	30	100	100	100	100	70	90	100	80	50	100	100	90	—
Wheat	0	30	30	60	40	20	50	80	40	20	50	30	50	40

	Compounds													
500 g ai/ha	149	150	151	152	153	154	155	156	157	158	159	160	161	162
Postemergence														
Barnyardgrass	80	0	20	20	90	90	90	90	70	0	80	90	70	90
Corn	40	10	20	20	80	80	70	70	40	20	30	60	30	40
Crabgrass, Large	90	20	30	30	100	100	100	100	80	20	40	90	90	90
Foxtail, Giant	90	0	30	50	100	100	100	100	90	0	90	90	90	90
Morningglory	100	0	70	60	100	100	100	90	80	10	90	90	50	90
Pigweed	100	50	80	90	100	100	100	100	100	80	100	100	100	100
Velvetleaf	100	10	50	60	100	100	100	100	—	0	60	100	80	100
Wheat	30	0	0	0	70	50	80	60	20	0	30	50	30	30

	Compounds													
500 g ai/ha	163	164	165	166	168	169	170	171	172	173	174	175	176	177
Postemergence														
Barnyardgrass	100	90	90	90	90	90	90	90	90	70	90	0	0	20
Corn	30	40	30	30	50	50	50	30	50	20	30	0	0	30
Crabgrass, Large	100	90	90	90	90	90	100	100	100	90	90	0	0	60
Foxtail, Giant	90	90	90	90	90	90	90	90	90	90	90	0	0	70
Morningglory	80	100	80	100	—	—	100	100	100	90	100	0	0	100
Pigweed	100	100	100	100	100	100	100	100	100	100	100	0	0	100
Velvetleaf	100	100	70	100	100	100	100	90	100	70	80	0	0	50
Wheat	40	60	30	40	50	40	50	40	50	30	40	0	0	30

	Compounds													
500 g ai/ha	178	179	180	181	182	183	184	185	186	187	188	189	190	191
Postemergence														
Barnyardgrass	80	90	80	30	80	90	30	90	0	0	90	80	100	100
Corn	30	30	30	10	20	50	20	50	20	0	50	40	90	80
Crabgrass, Large	90	90	90	50	90	90	90	90	0	0	90	90	100	100
Foxtail, Giant	90	90	90	80	100	90	80	90	0	0	90	90	100	100
Morningglory	100	100	100	90	100	100	100	100	10	0	100	80	100	100
Pigweed	100	100	100	100	100	100	100	100	60	0	100	100	100	100

TABLE A-continued

	Compounds													
Velvetleaf	100	100	100	70	100	100	90	100	20	0	90	90	100	100
Wheat	40	40	40	20	30	40	20	40	0	0	70	60	100	80

	Compounds									
500 g ai/ha	192	193	194	195	196	197	198	199	200	201
Postemergence										
Barnyardgrass	20	20	20	90	90	10	0	10	10	10
Corn	30	30	20	60	80	20	10	20	20	20
Crabgrass, Large	30	30	20	90	90	20	10	20	40	30
Foxtail, Giant	20	20	30	90	90	40	10	20	20	10
Morningglory	70	40	30	100	100	40	20	20	30	50
Pigweed	100	100	100	100	100	70	50	60	100	100
Velvetleaf	100	70	50	100	100	30	10	10	40	40
Wheat	10	10	20	30	70	0	0	0	0	10

	Compounds													
125 g ai/ha	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Postemergence														
Barnyardgrass	0	0	30	20	0	0	30	10	50	20	0	30	0	80
Corn	20	10	20	20	0	0	10	20	20	20	0	20	0	20
Crabgrass, Large	70	10	40	30	0	0	70	40	60	40	0	50	0	80
Foxtail, Giant	50	10	30	20	0	0	50	30	50	20	0	50	0	80
Morningglory	50	10	30	20	0	0	90	90	70	100	0	70	10	80
Pigweed	90	30	90	80	10	0	100	60	90	70	0	100	0	100
Velvetleaf	30	0	50	30	0	0	30	30	60	40	0	70	0	100
Wheat	10	0	30	20	0	0	0	0	0	0	0	10	0	30

	Compounds													
125 g ai/ha	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Postemergence														
Barnyardgrass	90	90	30	50	20	0	0	10	70	0	50	80	0	70
Corn	30	30	30	20	20	0	0	10	30	10	30	30	20	30
Crabgrass, Large	90	90	90	60	60	0	20	40	90	10	90	90	30	70
Foxtail, Giant	90	90	60	30	30	0	0	20	90	10	90	90	30	90
Morningglory	100	80	50	80	50	0	20	10	90	20	100	100	40	100
Pigweed	100	100	90	100	90	0	60	50	100	40	100	100	90	100
Velvetleaf	100	100	90	70	60	0	10	10	90	20	80	100	40	80
Wheat	30	20	20	20	10	0	0	10	20	10	40	60	20	40

	Compounds													
125 g ai/ha	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Postemergence														
Barnyardgrass	20	0	10	10	0	10	40	0	10	0	0	30	10	0
Corn	20	0	10	0	0	10	20	0	10	0	0	10	10	10
Crabgrass, Large	90	0	10	20	0	20	80	0	20	20	0	80	10	10
Foxtail, Giant	60	0	10	10	0	20	60	0	30	0	0	60	10	10
Morningglory	80	0	20	10	0	30	90	0	20	0	0	70	10	10
Pigweed	100	0	60	60	10	80	100	0	80	0	30	100	30	50
Velvetleaf	60	0	10	20	0	10	70	0	20	0	0	70	10	10
Wheat	0	0	0	0	0	0	10	0	0	0	0	20	0	0

	Compounds													
125 g ai/ha	43	44	45	47	48	49	50	51	52	53	54	55	56	57
Postemergence														
Barnyardgrass	10	20	10	90	10	10	0	0	20	90	70	90	10	0
Corn	20	30	10	20	10	10	0	0	10	30	30	20	10	0
Crabgrass, Large	30	30	60	80	50	60	0	0	50	90	80	80	50	0
Foxtail, Giant	20	20	20	80	30	30	0	0	50	90	80	90	20	0
Morningglory	0	20	40	90	10	20	0	0	40	—	—	—	—	0
Pigweed	50	70	100	100	100	80	10	10	100	100	100	100	100	0
Velvetleaf	20	60	40	100	30	30	0	0	30	80	90	100	40	0
Wheat	0	20	10	30	10	10	0	0	10	20	20	20	10	0

TABLE A-continued

Compounds														
	Compounds													
125 g ai/ha	58	59	60	61	62	63	64	65	66	68	69	70	71	72
Postemergence														
Barnyardgrass	0	0	0	0	0	0	0	10	0	0	10	0	0	0
Corn	0	0	0	10	0	0	0	10	0	0	10	10	0	0
Crabgrass, Large	0	0	0	0	0	0	0	20	10	10	10	10	10	0
Foxtail, Giant	0	0	0	0	0	0	0	20	0	10	10	10	10	0
Morningglory	0	0	0	10	0	0	0	—	0	0	20	10	10	0
Pigweed	50	0	0	40	0	0	0	90	10	10	30	40	10	10
Velvetleaf	0	0	0	10	0	0	0	30	0	—	10	10	0	0
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Compounds													
125 g ai/ha	73	74	75	76	77	78	79	80	82	83	84	86	87	88
Postemergence														
Barnyardgrass	10	0	0	0	0	0	0	30	0	0	0	0	0	10
Corn	10	0	0	10	0	0	0	20	0	0	10	0	0	0
Crabgrass, Large	20	0	10	10	10	10	0	40	0	0	10	0	0	30
Foxtail, Giant	10	0	10	10	10	10	0	30	0	0	10	0	0	10
Morningglory	20	0	0	10	10	0	0	40	0	0	30	0	0	10
Pigweed	70	0	30	50	90	50	0	100	0	0	40	0	0	80
Velvetleaf	20	0	10	0	10	10	0	80	0	0	10	0	0	10
Wheat	10	0	0	0	0	0	0	20	0	0	0	0	0	0
	Compounds													
125 g ai/ha	90	91	92	93	98	99	100	101	102	103	104	107	108	110
Postemergence														
Barnyardgrass	0	0	0	0	30	10	10	20	0	0	20	30	40	20
Corn	0	10	10	10	20	20	10	10	0	0	10	20	20	20
Crabgrass, Large	0	0	10	10	90	30	60	70	0	0	50	60	90	50
Foxtail, Giant	0	0	10	10	80	20	50	70	0	0	20	40	60	20
Morningglory	0	0	10	0	80	60	90	40	0	0	60	70	100	90
Pigweed	0	10	30	10	100	70	80	80	10	50	70	90	90	70
Velvetleaf	0	0	20	10	60	10	30	10	0	0	30	40	60	30
Wheat	0	0	0	0	10	0	0	0	0	0	0	20	20	10
	Compounds													
125 g ai/ha	111	112	114	115	116	119	120	121	122	125	126	127	128	129
Postemergence														
Barnyardgrass	20	0	30	20	10	10	60	0	40	0	20	10	0	90
Corn	20	20	20	10	20	10	20	0	20	20	20	10	10	30
Crabgrass, Large	90	50	30	50	40	40	80	0	80	60	90	10	10	90
Foxtail, Giant	80	20	30	30	30	20	80	0	60	50	60	10	0	90
Morningglory	70	60	60	90	70	20	90	0	90	60	70	20	30	100
Pigweed	90	90	80	80	50	70	90	0	100	90	100	40	30	100
Velvetleaf	20	50	30	10	20	20	50	0	80	30	40	20	20	70
Wheat	10	10	10	10	10	0	10	0	20	0	10	0	0	20
	Compounds													
1000 g ai/ha	94	95	96	97	105	106	109	117	118	123	124	130	131	132
Preemergence														
Barnyardgrass	70	50	70	30	10	50	100	100	70	10	90	50	20	90
Corn	0	10	0	0	0	10	40	50	20	0	10	0	0	0
Crabgrass, Large	100	100	100	40	50	90	100	100	100	60	100	90	90	100
Foxtail, Giant	100	100	90	20	—	—	100	100	100	80	100	90	90	100
Morningglory	60	0	40	0	10	20	50	40	20	0	40	40	10	60
Pigweed	100	90	100	0	90	90	100	100	100	80	100	90	90	100

TABLE A-continued

	Compounds													
Velvetleaf	20	40	0	0	10	0	30	30	10	10	80	20	0	60
Wheat	0	0	0	0	0	0	20	10	10	0	0	10	0	0

125 g ai/ha	135	136	137	138	139	140	141	142	143	144	145	146	147	148
Postemergence														
Barnyardgrass	0	60	70	90	90	10	80	100	20	10	80	30	80	80
Corn	10	20	20	50	30	20	30	50	40	10	40	20	30	20
Crabgrass, Large	10	60	90	90	90	20	90	100	80	50	90	80	80	80
Foxtail, Giant	0	90	90	90	90	20	90	100	80	30	90	80	70	80
Morningglory	0	70	80	100	80	50	80	100	50	20	100	90	90	80
Pigweed	20	100	100	100	100	100	100	100	100	100	100	100	100	100
Velvetleaf	10	90	80	100	90	20	70	100	40	40	100	70	50	100
Wheat	0	30	20	50	30	10	20	80	10	0	20	10	20	20

125 g ai/ha	149	150	151	152	153	154	155	156	157	158	159	160	161	162
Postemergence														
Barnyardgrass	30	0	10	20	90	90	90	90	20	0	50	70	30	80
Corn	30	0	10	10	60	30	40	40	20	0	20	30	10	20
Crabgrass, Large	80	0	10	20	100	100	100	100	40	0	20	90	70	90
Foxtail, Giant	80	0	10	30	90	90	90	90	80	0	40	90	60	90
Morningglory	90	0	40	50	90	80	90	90	60	0	60	90	30	90
Pigweed	100	10	60	60	100	100	100	100	100	10	90	100	100	100
Velvetleaf	60	0	30	40	100	100	100	100	40	0	20	90	40	90
Wheat	20	0	0	0	60	20	40	40	0	0	0	40	10	20

125 g ai/ha	163	164	165	166	168	169	170	171	172	173	174	175	176	177
Postemergence														
Barnyardgrass	70	90	40	70	90	80	90	80	90	30	70	0	0	0
Corn	20	30	20	20	20	10	30	20	30	20	20	0	0	20
Crabgrass, Large	70	90	70	90	90	90	100	90	90	60	90	0	0	10
Foxtail, Giant	60	90	60	90	90	80	90	80	90	30	80	0	0	20
Morningglory	30	100	60	90	—	—	100	100	100	90	70	0	0	90
Pigweed	100	100	100	100	100	100	100	100	100	80	100	0	0	60
Velvetleaf	40	100	40	80	100	100	100	70	90	50	70	0	0	20
Wheat	20	50	20	30	40	30	40	30	40	10	30	0	0	20

125 g ai/ha	178	179	180	181	182	183	184	185	186	187	188	189	190	191
Postemergence														
Barnyardgrass	30	90	50	0	30	80	10	70	0	0	90	60	100	60
Corn	20	20	20	0	10	20	10	20	10	0	40	20	60	30
Crabgrass, Large	90	90	90	50	70	90	50	90	0	0	90	80	100	90
Foxtail, Giant	60	90	90	30	50	90	30	90	0	0	90	90	100	90
Morningglory	90	100	100	90	60	100	30	100	0	0	90	60	100	100
Pigweed	100	100	100	90	100	100	100	100	20	0	100	100	100	100
Velvetleaf	60	90	70	30	70	100	40	100	0	0	70	70	100	80
Wheat	20	30	30	0	20	30	10	20	0	0	70	50	70	70

125 g ai/ha	192	193	194	195	196	197	198	199	200	201
Postemergence										
Barnyardgrass	0	10	10	90	80	0	0	10	0	0
Corn	10	10	0	30	70	0	0	10	10	10
Crabgrass, Large	10	10	10	90	90	10	0	10	10	20
Foxtail, Giant	10	10	10	90	90	10	0	10	10	0
Morningglory	30	10	10	80	100	30	10	10	10	10
Pigweed	40	70	40	100	100	30	10	20	50	60
Velvetleaf	20	30	30	90	100	20	10	10	10	20
Wheat	0	0	0	30	50	0	0	0	0	0

TABLE A-continued

Compounds					
	Compounds				Compound
1000 g ai/ha	133	134	167	31 g ai/ha	34
Preemergence					
Barnyardgrass	40	30	100	Barnyardgrass	0
Corn	10	10	30	Corn	0
Crabgrass, Large	90	100	100	Crabgrass, Large	0
Foxtail, Giant	90	100	100	Foxtail, Giant	0
Morningglory	40	10	—	Morningglory	0
Pigweed	90	90	100	Pigweed	0
Velvetleaf	40	0	20	Velvetleaf	0
Wheat	0	0	80	Wheat	0

	Compounds													
500 g ai/ha	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Preemergence														
Barnyardgrass	50	10	50	60	0	0	100	80	70	10	0	80	0	90
Corn	0	0	10	0	0	0	30	0	10	0	0	10	0	30
Crabgrass, Large	100	90	100	90	0	0	100	100	100	90	0	100	0	100
Foxtail, Giant	100	50	100	100	0	0	100	90	90	80	0	100	0	100
Morningglory	20	0	50	40	0	0	80	90	60	10	0	40	0	80
Pigweed	90	60	100	100	0	0	100	100	100	80	0	100	0	100
Velvetleaf	10	0	10	0	0	0	60	60	50	20	0	70	0	90
Wheat	0	0	40	30	0	0	0	10	0	0	0	0	0	50

	Compounds													
500 g ai/ha	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Preemergence														
Barnyardgrass	100	100	90	30	50	0	10	10	100	0	90	90	10	90
Corn	50	20	20	0	0	0	0	0	40	0	30	50	0	20
Crabgrass, Large	100	100	100	90	80	0	60	40	100	20	100	100	40	90
Foxtail, Giant	100	100	100	90	90	0	30	80	100	70	100	100	80	100
Morningglory	80	80	50	50	50	0	0	0	80	0	80	80	0	—
Pigweed	100	100	100	100	90	0	50	10	100	20	100	100	80	100
Velvetleaf	80	80	40	30	30	0	0	0	100	0	80	90	0	80
Wheat	50	20	0	0	0	0	0	0	70	0	80	80	0	20

	Compounds													
500 g ai/ha	29	30	31	32	33	35	36	37	38	39	40	41	42	43
Preemergence														
Barnyardgrass	50	0	0	0	0	90	0	90	0	0	80	20	10	20
Corn	0	0	0	0	0	30	0	—	0	0	10	0	0	10
Crabgrass, Large	100	0	60	30	10	100	10	100	60	50	100	70	50	80
Foxtail, Giant	100	0	90	80	0	100	0	100	20	10	100	70	70	90
Morningglory	10	0	0	0	0	50	0	20	0	0	10	10	10	—
Pigweed	90	0	50	70	0	100	0	100	10	0	100	50	60	60
Velvetleaf	50	0	0	0	0	50	0	10	0	0	20	10	0	0
Wheat	0	0	0	0	0	0	0	0	0	0	20	0	0	0

	Compounds													
500 g ai/ha	44	45	47	48	49	50	51	52	53	54	55	56	57	58
Preemergence														
Barnyardgrass	30	10	100	30	30	0	0	90	100	100	100	80	0	0
Corn	20	0	30	0	10	0	0	10	20	40	50	10	0	0
Crabgrass, Large	90	70	100	100	100	20	0	100	100	100	100	100	0	10
Foxtail, Giant	90	60	100	100	100	40	10	100	100	100	100	100	0	10
Morningglory	—	10	80	20	10	0	0	20	40	90	80	10	0	0
Pigweed	90	20	100	90	100	10	0	—	100	100	100	90	0	30

TABLE A-continued

	Compounds													
Velvetleaf	50	10	100	0	10	0	0	10	50	60	70	10	0	0
Wheat	30	0	40	0	20	0	0	0	30	30	40	10	0	0

	Compounds													
500 g ai/ha	59	60	61	62	63	64	65	66	68	69	70	71	72	73
Preemergence														
Barnyardgrass	0	0	0	0	0	0	70	0	0	0	0	0	0	40
Corn	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Crabgrass, Large	0	0	10	0	0	0	100	50	0	10	40	10	10	90
Foxtail, Giant	0	0	10	0	0	0	100	70	0	0	50	0	20	90
Morningglory	0	0	0	0	0	0	20	0	0	0	0	0	0	10
Pigweed	0	0	10	0	0	0	100	10	0	10	10	0	10	100
Velvetleaf	0	0	0	0	0	0	10	0	0	0	0	0	0	10
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	10

	Compounds													
500 g ai/ha	74	75	76	77	78	79	80	82	83	84	86	87	88	90
Preemergence														
Barnyardgrass	0	20	0	0	20	0	70	0	0	0	0	0	10	0
Corn	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Crabgrass, Large	0	70	40	10	80	0	100	0	0	60	0	0	50	0
Foxtail, Giant	0	90	80	10	70	0	100	0	0	30	0	0	40	0
Morningglory	0	—	0	0	10	0	60	0	0	0	0	0	0	0
Pigweed	0	40	20	10	70	0	100	0	0	50	0	0	50	0
Velvetleaf	0	0	0	0	20	0	70	0	0	0	0	0	0	0
Wheat	0	10	0	0	0	0	40	0	0	0	0	0	0	0

	Compounds													
500 g ai/ha	91	92	93	98	99	100	101	102	103	104	107	108	110	111
Preemergence														
Barnyardgrass	0	0	0	60	10	20	80	0	0	20	80	80	0	80
Corn	0	0	0	10	0	0	10	0	0	0	10	0	0	20
Crabgrass, Large	0	40	0	100	60	90	100	0	10	90	100	100	20	100
Foxtail, Giant	0	20	0	100	80	70	100	0	0	90	100	100	20	100
Morningglory	0	0	0	10	0	0	10	0	0	0	30	20	20	30
Pigweed	0	10	0	100	60	90	100	0	30	90	100	100	50	90
Velvetleaf	0	0	0	50	20	0	0	0	0	30	10	20	10	50
Wheat	0	0	0	20	0	0	0	0	0	0	0	0	0	0

	Compounds												
500 g ai/ha	112	114	115	116	119	120	121	122	125	126	127	128	129
Preemergence													
Barnyardgrass	40	0	60	30	30	100	0	70	50	80	10	0	100
Corn	0	0	10	10	0	30	0	20	0	20	0	0	60
Crabgrass, Large	100	30	100	100	100	100	10	100	90	100	40	20	100
Foxtail, Giant	90	10	100	90	100	100	0	100	90	90	30	20	100
Morningglory	20	30	10	10	10	30	0	50	10	30	0	20	60
Pigweed	100	10	100	100	100	100	0	100	90	100	20	0	100
Velvetleaf	20	10	20	20	10	70	0	60	50	40	0	0	70
Wheat	0	0	10	10	0	20	0	20	0	0	0	0	50

	Compounds													
500 g ai/ha	135	136	137	138	139	140	141	142	143	144	145	146	147	148
Preemergence														
Barnyardgrass	0	100	70	100	100	30	100	100	90	30	100	100	100	100
Corn	0	10	0	60	30	0	30	80	20	0	40	10	30	20
Crabgrass, Large	0	100	90	90	100	50	100	100	100	100	100	100	100	100
Foxtail, Giant	0	100	90	100	100	70	100	100	100	100	100	100	100	100
Morningglory	0	60	60	90	70	0	60	80	0	0	60	60	80	90
Pigweed	0	90	100	100	100	80	100	100	100	100	100	100	100	100
Velvetleaf	0	60	20	100	90	30	60	90	20	0	80	50	50	70
Wheat	0	10	0	60	50	0	20	80	10	0	60	30	50	50

TABLE A-continued

Compounds

500 g ai/ha	149	150	151	152	153	154	155	156	157	158	159	160	161	162
Preemergence														
Barnyardgrass	90	0	0	0	100	100	100	100	100	0	80	100	60	100
Corn	20	0	0	0	80	70	80	70	0	0	0	40	10	30
Crabgrass, Large	100	0	10	10	100	100	100	100	90	0	30	100	100	100
Foxtail, Giant	100	0	20	20	100	100	100	100	100	0	90	100	100	100
Morningglory	30	0	0	0	100	80	90	90	0	0	0	70	10	90
Pigweed	100	0	60	40	100	100	100	100	100	0	90	100	100	100
Velvetleaf	50	0	0	0	100	70	—	—	0	0	0	70	50	100
Wheat	50	0	0	0	70	20	70	80	0	0	0	50	10	30

Compounds

500 g ai/ha	163	164	165	166	168	169	170	171	172	173	174	175	176	177
Preemergence														
Barnyardgrass	100	100	100	100	100	90	—	—	—	—	—	0	0	70
Corn	10	30	10	30	40	20	40	30	60	0	20	0	0	0
Crabgrass, Large	100	100	100	100	100	100	100	100	100	100	100	0	0	100
Foxtail, Giant	100	100	100	100	100	100	100	100	100	100	100	0	0	100
Morningglory	30	90	—	—	50	40	90	60	80	10	40	0	0	40
Pigweed	100	100	100	100	100	100	100	100	100	70	100	0	0	50
Velvetleaf	20	100	10	70	90	90	100	80	90	20	70	0	0	20
Wheat	0	60	0	50	60	50	80	60	70	0	30	0	0	0

Compounds

500 g ai/ha	178	179	180	181	182	183	184	185	186	187	188	189	190	191
Preemergence														
Barnyardgrass	100	100	80	20	90	100	50	100	0	0	100	90	100	100
Corn	10	30	20	0	10	30	0	30	0	0	20	10	90	60
Crabgrass, Large	100	100	100	80	100	100	100	100	0	0	100	100	100	100
Foxtail, Giant	100	100	100	80	100	100	90	100	0	0	100	100	100	100
Morningglory	60	70	70	10	10	90	10	100	0	0	90	30	80	30
Pigweed	100	100	100	90	100	100	100	100	0	0	100	100	100	100
Velvetleaf	60	100	60	0	70	80	30	100	0	0	90	60	100	80
Wheat	10	50	40	0	0	60	0	50	0	0	50	50	80	70

Compounds

500 g ai/ha	192	193	194	195	196	197	198	199	200	201
Preemergence										
Barnyardgrass	0	0	0	100	100	0	0	0	0	0
Corn	0	0	0	30	50	0	0	0	0	0
Crabgrass, Large	70	40	10	100	100	0	0	70	100	20
Foxtail, Giant	80	70	30	100	100	0	0	50	100	20
Morningglory	10	0	0	60	90	0	0	0	10	0
Pigweed	40	20	10	100	100	0	0	30	100	10
Velvetleaf	0	0	0	80	100	0	0	0	0	0
Wheat	0	0	0	50	70	0	0	0	0	0

Compounds

125 g ai/ha	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Preemergence														
Barnyardgrass	20	0	10	10	0	0	40	20	30	0	0	30	0	70
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Crabgrass, Large	70	10	90	80	0	0	100	90	90	40	0	90	0	90
Foxtail, Giant	60	10	90	80	0	0	90	60	80	20	0	80	0	100
Morningglory	0	0	0	0	0	0	30	30	50	0	0	10	0	60
Pigweed	60	0	70	50	0	0	100	90	90	60	0	80	0	90

TABLE A-continued

	Compounds													
Velvetleaf	0	0	0	0	0	0	30	20	30	0	0	60	0	70
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	30

	Compounds													
125 g ai/ha	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Preemergence														
Barnyardgrass	100	90	30	20	20	0	0	0	70	0	80	90	0	50
Corn	20	10	0	0	0	0	0	0	10	0	10	30	0	20
Crabgrass, Large	100	90	100	90	60	0	0	10	100	0	90	100	20	30
Foxtail, Giant	100	100	90	80	50	0	0	20	100	20	100	100	10	100
Morningglory	60	—	0	10	10	0	0	0	80	0	30	80	0	20
Pigweed	100	90	90	80	80	0	0	10	100	0	100	100	0	100
Velvetleaf	70	30	30	20	20	0	0	0	50	0	20	80	0	20
Wheat	30	10	0	0	0	0	0	0	0	0	20	50	0	0

	Compounds													
125 g ai/ha	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Preemergence														
Barnyardgrass	10	0	0	0	0	0	60	0	30	0	0	30	10	0
Corn	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Crabgrass, Large	90	0	0	10	0	50	90	0	90	50	0	100	20	10
Foxtail, Giant	80	0	30	10	0	30	80	0	90	0	0	100	40	10
Morningglory	0	0	0	0	0	0	20	0	0	0	0	0	0	0
Pigweed	50	0	0	0	0	10	90	0	70	0	0	90	20	10
Velvetleaf	0	0	0	0	0	0	30	0	0	0	0	10	10	0
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Compounds													
125 g ai/ha	43	44	45	47	48	49	50	51	52	53	54	55	56	57
Preemergence														
Barnyardgrass	0	0	0	90	0	10	0	0	20	80	80	90	0	0
Corn	0	0	0	20	0	0	0	0	0	0	10	20	0	0
Crabgrass, Large	30	60	70	100	30	80	10	0	100	100	100	100	90	0
Foxtail, Giant	20	70	50	100	40	80	10	0	100	100	100	100	30	0
Morningglory	—	—	0	70	0	0	0	0	10	30	60	50	0	0
Pigweed	50	20	10	100	40	60	0	0	100	90	100	100	30	0
Velvetleaf	0	0	0	80	0	0	0	0	0	10	30	40	0	0
Wheat	0	0	0	30	0	10	0	0	0	10	10	10	0	0

	Compounds													
125 g ai/ha	58	59	60	61	62	63	64	65	66	68	69	70	71	72
Preemergence														
Barnyardgrass	0	0	0	0	0	0	0	10	0	0	0	0	0	0
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabgrass, Large	0	0	0	0	0	0	0	30	10	0	0	0	0	0
Foxtail, Giant	0	0	0	0	0	0	0	90	10	0	0	0	0	0
Morningglory	0	0	0	0	0	0	0	10	0	0	0	0	0	0
Pigweed	0	0	0	0	0	0	0	80	0	0	0	0	0	0
Velvetleaf	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Compounds													
125 g ai/ha	73	74	75	76	77	78	79	80	82	83	84	86	87	88
Preemergence														
Barnyardgrass	0	0	10	0	0	0	0	20	0	0	0	0	0	0
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabgrass, Large	50	0	20	10	0	60	0	90	0	0	0	0	0	0
Foxtail, Giant	60	0	50	10	0	20	0	90	0	0	0	0	0	0
Morningglory	0	0	—	0	0	0	0	0	0	0	0	0	0	0
Pigweed	30	0	30	0	0	60	0	100	0	0	0	0	0	0
Velvetleaf	0	0	0	0	0	10	0	30	0	0	0	0	0	0
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE A-continued

Compounds

125 g ai/ha	90	91	92	93	98	99	100	101	102	103	104	107	108	110
Preemergence														
Barnyardgrass	0	0	0	0	10	0	0	50	0	0	10	30	30	0
Corn	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabgrass, Large	0	0	10	0	80	30	10	100	0	0	60	100	90	0
Foxtail, Giant	0	0	10	0	70	10	20	100	0	0	60	90	80	0
Morningglory	0	0	0	0	0	0	0	0	0	0	0	20	0	10
Pigweed	0	0	0	0	60	20	10	100	0	10	30	70	80	0
Velvetleaf	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Wheat	0	0	0	0	0	0	0	0	0	0	0	0	0	0

125 g ai/ha	111	112	114	115	116	119	120	121	122	125	126	127	128	129
Preemergence														
Barnyardgrass	20	0	0	30	0	0	90	0	20	30	70	0	0	100
Corn	0	0	0	0	0	0	20	0	10	0	0	0	0	50
Crabgrass, Large	80	80	0	80	70	70	100	0	90	80	100	10	0	100
Foxtail, Giant	70	60	0	60	60	50	100	0	90	80	70	10	0	100
Morningglory	0	0	10	0	0	0	10	0	20	0	10	0	0	50
Pigweed	70	90	0	100	50	60	100	0	90	70	100	0	0	100
Velvetleaf	0	0	0	0	0	0	40	0	30	0	10	0	0	60
Wheat	0	0	0	0	0	0	10	0	0	0	0	0	0	10

125 g ai/ha	135	136	137	138	139	140	141	142	143	144	145	146	147	148
Preemergence														
Barnyardgrass	0	70	50	90	80	0	40	100	30	0	100	90	90	90
Corn	0	0	0	30	10	0	0	30	0	0	10	0	10	10
Crabgrass, Large	0	80	90	90	100	20	100	100	90	50	100	100	100	100
Foxtail, Giant	0	100	90	100	100	20	100	100	90	50	100	100	100	100
Morningglory	0	20	40	70	50	0	30	50	0	0	10	10	—	40
Pigweed	0	90	100	100	100	30	100	100	100	50	100	100	100	100
Velvetleaf	0	30	20	70	30	20	20	60	0	0	50	10	20	20
Wheat	0	0	0	30	10	0	0	70	0	0	20	0	30	30

125 g ai/ha	149	150	151	152	153	154	155	156	157	158	159	160	161	162
Preemergence														
Barnyardgrass	60	0	0	0	100	100	100	100	20	0	10	100	20	90
Corn	10	0	0	0	70	20	60	40	0	0	0	20	10	20
Crabgrass, Large	90	0	0	0	100	100	100	100	20	0	10	100	100	100
Foxtail, Giant	90	0	0	0	100	100	100	100	90	0	40	100	100	100
Morningglory	10	0	0	0	80	20	80	80	0	0	0	40	10	30
Pigweed	90	0	10	0	100	100	100	100	80	0	70	100	100	100
Velvetleaf	20	0	0	0	80	30	—	30	0	0	0	50	0	100
Wheat	0	0	0	0	50	0	10	20	0	0	0	30	0	10

125 g ai/ha	163	164	165	166	168	169	170	171	172	173	174	175	176	177
Preemergence														
Barnyardgrass	90	90	30	90	90	80	—	—	—	—	—	0	0	0
Corn	0	30	0	10	20	20	30	10	30	0	10	0	0	0
Crabgrass, Large	100	100	100	100	100	100	100	100	100	60	100	0	0	90
Foxtail, Giant	100	100	90	100	100	100	100	100	100	80	90	0	0	90
Morningglory	10	80	—	—	20	20	70	50	60	0	20	0	0	20
Pigweed	100	100	100	100	100	100	100	100	100	50	100	0	0	10

TABLE A-continued

	Compounds													
Velvetleaf	0	80	0	30	30	50	90	60	80	0	50	0	0	0
Wheat	0	50	0	10	40	20	60	10	50	0	0	0	0	0

	Compounds													
125 g ai/ha	178	179	180	181	182	183	184	185	186	187	188	189	190	191
Preemergence														
Barnyardgrass	20	90	60	0	30	90	0	100	0	0	90	80	100	90
Corn	0	20	10	0	0	20	0	10	0	0	10	10	30	20
Crabgrass, Large	90	100	100	10	90	100	70	100	0	0	100	100	100	100
Foxtail, Giant	90	100	100	10	90	100	70	100	0	0	100	100	100	100
Morningglory	0	40	40	0	0	70	0	60	0	0	20	20	80	20
Pigweed	100	100	100	60	80	100	90	100	0	0	100	100	100	100
Velvetleaf	10	80	50	0	60	70	0	90	0	0	40	20	40	30
Wheat	0	20	20	0	0	30	0	30	0	0	30	20	60	40

	Compounds									
125 g ai/ha	192	193	194	195	196	197	198	199	200	201
Preemergence										
Barnyardgrass	0	0	0	90	100	0	0	0	0	0
Corn	0	0	0	20	30	0	0	0	0	0
Crabgrass, Large	0	0	0	100	100	0	0	20	80	0
Foxtail, Giant	0	10	0	100	100	0	0	0	70	0
Morningglory	0	0	0	50	60	0	0	0	0	0
Pigweed	10	0	0	100	100	0	0	10	50	0
Velvetleaf	0	0	0	70	80	0	0	0	0	0
Wheat	0	0	0	20	50	0	0	0	0	0

Test B

Seeds selected from rice (*Oryza sativa*), sedge, umbrella (small-flower umbrella sedge *Cyperus difformis*), ducksalad (*Heteranthera limosa*), and barnyardgrass (*Echinochloa crus-galli*) were grown to the 2-leaf stage for testing. At time of treatment, test pots were flooded to 3 cm above the soil surface, treated by application of test compounds directly to the paddy water, and then maintained at that water depth for the duration of the test.

Treated plants and controls were maintained in a greenhouse for 13 to 15 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table B, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE B

	Compounds													
250 g ai/ha	3	4	5	6	24	25	26	27	28	34	43	44	53	54
Flood														
Barnyardgrass	0	20	0	0	0	30	60	20	90	65	0	0	60	30
Ducksalad	0	40	0	0	0	90	40	50	95	75	85	0	85	85
Rice	0	0	0	0	0	35	80	10	80	35	0	0	50	30
Sedge, Umbrella	0	70	0	0	0	95	90	20	95	90	100	0	85	85

	Compounds				
250 g ai/ha	55	56	65	86	87
Flood					
Barnyardgrass	70	30	30	0	0
Ducksalad	100	80	60	0	0

TABLE B-continued

Rice	60	40	25	0	0
Sedge, Umbrella	100	80	75	50	50

	Compounds													
250 g ai/ha	135	136	137	138	139	140	141	142	143	144	145	146	147	148
Flood														
Barnyardgrass	0	45	45	80	65	30	20	70	40	30	90	50	55	65
Ducksalad	0	75	50	90	70	0	85	90	0	40	60	60	40	85
Rice	0	35	40	50	45	0	35	60	30	20	80	35	50	45
Sedge, Umbrella	0	85	70	90	80	0	85	90	75	80	85	80	80	85

	Compounds													
250 g ai/ha	149	150	151	152	153	154	155	156	157	158	159	160	168	169
Flood														
Barnyardgrass	40	20	0	0	80	60	75	75	0	0	30	65	80	75
Ducksalad	60	0	0	0	90	80	80	90	20	0	20	90	80	85
Rice	30	0	30	0	60	45	50	50	0	75	30	55	60	55
Sedge, Umbrella	60	0	0	0	90	80	80	85	40	0	60	85	85	85

	Compounds												
250 g ai/ha	170	171	172	173	174	184	185	192	195	196	197	198	201
Flood													
Barnyardgrass	80	70	80	0	70	25	90	0	85	85	0	0	0
Ducksalad	35	0	0	0	50	0	65	0	100	100	0	0	0
Rice	60	60	50	0	50	25	65	0	60	70	0	0	0
Sedge, Umbrella	90	85	75	0	75	60	95	0	100	100	0	0	0

	Compounds													
125 g ai/ha	161	162	163	164	165	166	167	175	176	177	178	179	180	181
Flood														
Barnyardgrass	0	70	15	60	10	70	0	0	0	0	0	0	0	0
Ducksalad	0	0	70	0	40	70	0	0	0	0	30	65	60	0
Rice	20	25	15	45	20	80	30	0	0	0	20	35	30	20
Sedge, Umbrella	80	80	80	75	70	70	50	0	0	40	60	75	70	0

	Compounds											
125 g ai/ha	182	183	186	187	188	189	190	191	193	194	199	200
Flood												
Barnyardgrass	0	30	0	0	75	0	70	50	0	0	0	0
Ducksalad	0	65	0	0	90	20	70	20	0	0	0	0
Rice	15	45	0	0	50	35	50	50	0	0	0	0
Sedge, Umbrella	50	95	0	0	100	0	95	50	0	0	0	0

Test C

Seeds of plant species selected from blackgrass (*Alopecurus myosuroides*), bromegrass, downy (downy bromegrass, *Bromus tectorum*), foxtail, green (green foxtail, *Setaria viridis*), ryegrass, Italian (Italian ryegrass, *Lolium multiflorum*), winter wheat (*Triticum aestivum*), wild oat (*Avena fatua*), *galium* (catchweed bedstraw, *Galium aparine*), bermudagrass (*Cynodon dactylon*), surinam grass (*Brachiaria decumbens*), cocklebur (common cocklebur, *Xanthium strumarium*), corn (*Zea mays*), large crabgrass (*Digitaria sanguinalis*), woolly cupgrass (*Eriochloa villosa*), foxtail, giant (giant foxtail, *Setaria* faberii), goosegrass (*Eleusine indica*), johnsongrass (*Sorghum halepense*), *kochia* (*Kochia scoparia*), lambsquarters (*Chenopodium album*), morningglory (*Ipomoea coccinea*), nightshade (eastern black nightshade, *Solanum* ptycanthum), nutsedge, yellow (yellow nutsedge, *Cyperus esculentus*), pigweed (*Amaranthus retroflexus*), ragweed (common ragweed, *Ambrosia* elation), soybean (*Glycine max*), common (oilseed) sunflower (*Helianthus annuus*), Russian thistle (*Salsola kali*) and velvetleaf (*Abutilon theophrasti*) were planted into a blend of loam soil and sand and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these crop and weed species and also barley (winter barley, *Hordeum vulgare*), canarygrass (*Phalaris minor*), chickweed (common chickweed, *Stellaria media*) windgrass (*Apera spica-venti*) and deadnettle (henbit deadnettle, *Lamium amplexicaule*) were planted in pots containing Redi-Earth® planting medium (Scotts Company, 14111 Scottslawn Road, Marysville, Ohio 43041) comprising spaghnum peat moss, vermiculite, wetting agent and starter nutrients and treated with postemergence applications of test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments.

Plant species in the flooded paddy test consisted of rice (*Oryza sativa*), sedge, umbrella (small-flower umbrella sedge, *Cyperus difformis*), ducksalad (*Heteranthera limosa*) and barnyardgrass (*Echinochloa crus-galli*) grown to the 2-leaf stage for testing. At time of treatment, test pots were flooded to 3 cm above the soil surface, treated by application of test compounds directly to the paddy water, and then maintained at that water depth for the duration of the test.

Treated plants and controls were maintained in a greenhouse for 13 to 15 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table C, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE C

	Compounds													
250 g ai/ha	1	2	7	8	9	10	11	12	13	14	15	16	17	18
Flood														
Barnyardgrass	0	0	20	0	30	0	0	60	0	70	75	80	45	0
Ducksalad	0	0	70	45	0	0	0	70	0	60	60	100	20	0
Rice	0	0	15	0	0	0	0	25	0	45	50	50	45	0
Sedge, Umbrella	0	70	85	75	85	0	0	80	0	75	80	95	75	65

	Compounds													
250 g ai/ha	19	20	21	22	23	29	30	31	32	33	35	36	37	38
Flood														
Barnyardgrass	0	0	0	0	25	20	0	0	0	0	30	0	35	0
Ducksalad	0	0	0	0	85	0	0	0	0	0	75	0	70	0
Rice	0	0	0	0	30	0	0	0	0	0	0	0	20	0
Sedge, Umbrella	70	0	0	0	90	75	30	0	0	0	80	0	0	0

	Compounds													
250 g ai/ha	39	40	41	42	45	47	48	49	50	51	52	57	58	59
Flood														
Barnyardgrass	0	30	0	0	0	80	30	15	0	0	75	0	0	0
Ducksalad	40	70	0	0	0	90	65	40	0	0	95	0	0	0
Rice	10	25	0	0	0	60	20	0	0	0	40	0	0	0
Sedge, Umbrella	20	80	0	0	0	90	45	75	0	0	85	0	0	0

	Compounds													
250 g ai/ha	60	61	62	63	64	66	68	70	71	72	73	74	75	76
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	0	0	0	0	0	0	0	0	0	85	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Compounds													
250 g ai/ha	77	78	79	80	82	83	84	88	90	91	92	93	94	95
Flood														
Barnyardgrass	0	20	0	20	0	0	10	0	0	0	0	0	0	0
Ducksalad	0	0	0	0	0	30	40	0	0	0	0	0	60	0
Rice	0	0	0	0	0	25	20	0	0	0	0	0	0	0
Sedge, Umbrella	0	0	0	70	0	30	20	0	0	0	0	0	75	0

	Compounds													
250 g ai/ha	96	98	101	105	106	107	108	109	111	115	116	117	118	119
Flood														
Barnyardgrass	10	70	60	0	40	25	30	75	35	60	60	80	65	30
Ducksalad	50	70	65	0	70	40	45	80	80	20	50	85	70	80

TABLE C-continued

Rice	0	40	20	0	30	25	20	25	30	40	30	40	20	25
Sedge, Umbrella	80	80	75	0	80	80	85	85	85	80	85	85	75	85
	Compounds													
250 g ai/ha	120	122	123	124	125	126	129	130	131	132	133	134		
Flood														
Barnyardgrass	80	40	0	50	10	40	85	15	10	0	15	15		
Ducksalad	85	65	75	90	90	65	90	20	20	20	20	0		
Rice	80	30	10	20	10	20	50	15	0	0	0	0		
Sedge, Umbrella	90	85	75	90	85	80	95	75	0	65	50	0		
	Compounds													
125 g ai/ha	7	8	16	17	18	19	20	21	22	23	29	30	31	32
Flood														
Barnyardgrass	0	0	70	40	0	0	0	0	0	20	0	0	0	0
Ducksalad	30	0	95	0	0	0	0	0	0	60	0	0	0	0
Rice	0	0	40	35	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	50	0	95	30	40	0	0	0	0	80	70	20	0	0
	Compounds													
125 g ai/ha	33	35	36	40	41	45	47	49	57	58	59	60	61	62
Flood														
Barnyardgrass	0	0	0	30	0	0	80	10	0	0	0	0	0	0
Ducksalad	0	70	0	60	0	0	90	30	0	0	0	0	0	0
Rice	0	0	0	20	0	0	60	0	0	0	0	0	0	0
Sedge, Umbrella	0	80	0	80	0	0	90	70	0	0	0	0	0	0
	Compounds													
125 g ai/ha	63	64	68	70	71	72	73	74	75	76	77	78	79	80
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Compounds													
125 g ai/ha	82	83	84	88	90	91	92	93	94	98	101	105	106	107
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	30	55	0	20	20
Ducksalad	0	20	0	0	0	0	0	0	40	30	50	0	70	20
Rice	0	20	20	0	0	0	0	0	0	30	15	0	25	0
Sedge, Umbrella	0	20	0	0	0	0	0	0	60	40	50	0	75	60
	Compounds													
125 g ai/ha	108	109	111	115	116	117	118	119	120	122	123	124	125	126
Barnyardgrass	20	40	20	45	40	65	50	25	80	40	0	50	0	30
Ducksalad	30	60	70	0	30	80	70	80	80	60	75	90	75	20

TABLE C-continued

Rice	15	15	25	30	20	25	15	25	70	25	0	15	0	10
Sedge, Umbrella	75	85	80	75	75	75	70	85	90	85	50	90	80	75

125 g ai/ha	Compound 129
Flood	
Barnyardgrass	80
Ducksalad	80
Rice	40
Sedge, Umbrella	85

	Compounds													
62 g ai/ha	1	2	7	8	9	10	11	12	13	14	15	16	17	18
Flood														
Barnyardgrass	0	0	0	0	0	0	0	40	0	50	65	65	20	0
Ducksalad	0	0	0	0	0	0	0	60	0	40	40	85	0	0
Rice	0	0	0	0	0	0	0	0	0	40	45	30	15	0
Sedge, Umbrella	0	0	40	0	40	0	0	50	0	40	75	90	20	0

	Compounds													
62 g ai/ha	19	20	21	22	23	29	30	31	32	33	35	36	37	38
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	10	0
Ducksalad	0	0	0	0	60	0	0	0	0	0	65	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	10	0
Sedge, Umbrella	0	0	0	0	75	60	0	0	0	0	75	0	0	0

	Compounds													
62 g ai/ha	39	40	41	42	45	47	48	49	50	51	52	57	58	59
Flood														
Barnyardgrass	0	20	0	0	0	50	10	0	0	0	40	0	0	0
Ducksalad	0	30	0	0	0	90	20	0	0	0	80	0	0	0
Rice	0	10	0	0	0	50	10	0	0	0	15	0	0	0
Sedge, Umbrella	0	75	0	0	0	85	0	0	0	0	65	0	0	0

	Compounds													
62 g ai/ha	60	61	62	63	64	66	68	70	71	72	73	74	75	76
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Compounds													
62 g ai/ha	77	78	79	80	82	83	84	88	90	91	92	93	94	95
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	0	0	0	0	20	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	20	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	0	0	0	0	20	0	0	0	0	0	0	50	0

	Compounds													
62 g ai/ha	96	98	101	105	106	107	108	109	111	115	116	117	118	119
Flood														
Barnyardgrass	10	0	0	0	0	15	0	20	0	40	35	60	30	20
Ducksalad	40	0	20	0	60	0	0	20	30	0	0	50	30	50

TABLE C-continued

Rice	0	0	0	0	0	0	0	15	0	20	0	15	0	15
Sedge, Umbrella	75	0	0	0	50	40	20	63	65	70	60	70	65	75

	Compounds											
62 g ai/ha	120	122	123	124	125	126	129	130	131	132	133	134
Flood												
Barnyardgrass	65	20	0	40	0	0	75	0	0	0	0	0
Ducksalad	70	0	40	90	0	0	75	0	0	0	0	0
Rice	60	0	0	0	0	0	30	0	0	0	0	0
Sedge, Umbrella	85	75	0	90	40	40	75	30	0	0	0	0

	Compounds													
31 g ai/ha	7	8	16	17	18	19	20	21	22	23	29	30	31	32
Flood														
Barnyardgrass	0	0	25	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	0	70	0	0	0	0	0	0	50	0	0	0	0
Rice	0	0	20	10	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	30	0	80	0	0	0	0	0	0	60	50	0	0	0

	Compounds													
31 g ai/ha	33	35	36	40	41	45	47	49	57	58	59	60	61	62
Flood														
Barnyardgrass	0	0	0	20	0	0	40	0	0	0	0	0	0	0
Ducksalad	0	40	0	30	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	30	0	0	0	0	0	0	0
Sedge, Umbrella	0	75	0	70	0	0	75	0	0	0	0	0	0	0

	Compounds													
31 g ai/ha	63	64	68	70	71	72	73	74	75	76	77	78	79	80
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Compounds													
31 g ai/ha	82	83	84	88	90	91	92	93	94	98	101	105	106	107
Flood														
Barnyardgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ducksalad	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Sedge, Umbrella	0	10	0	0	0	0	0	0	0	0	0	0	50	0

	Compounds										
31 g ai/ha	108	109	111	117	118	122	123	124	125	126	129
Flood											
Barnyardgrass	0	0	0	50	20	10	0	20	0	0	55
Ducksalad	0	0	0	30	0	0	0	20	0	0	70
Rice	0	15	0	15	0	0	0	0	0	0	20
Sedge, Umbrella	20	38	45	65	40	70	0	50	0	30	75

	Compounds									
250 g ai/ha	14	16	23	25	26	28	47	106	120	129
Postemergence										
Barley	50	45	30	30	40	35	55	40	55	50
Bermudagrass	65	65	30	25	30	25	75	80	10	70
Blackgrass	85	80	25	60	90	60	90	60	85	80
Bromegrass, Downy	45	25	5	10	50	35	65	40	—	40
Canarygrass	85	90	15	55	90	90	90	80	90	85

TABLE C-continued

Chickweed	80	100	70	98	100	100	—	98	100	98
Cocklebur	75	45	50	20	65	25	70	55	65	25
Corn	15	15	30	25	25	25	25	55	10	65
Crabgrass, Large	60	60	35	65	40	25	50	65	45	85
Cupgrass, Woolly	65	75	50	45	55	40	90	50	45	70
Deadnettle	100	100	98	100	100	100	100	90	100	100
Foxtail, Giant	35	50	25	60	60	50	98	55	55	65
Foxtail, Green	90	—	50	70	85	85	100	85	100	95
Galium	80	90	90	55	75	80	98	80	—	90
Goosegrass	75	10	30	40	70	45	75	55	45	55
Johnsongrass	75	45	20	15	40	10	50	55	45	70
Kochia	95	98	85	90	98	95	—	90	98	98
Lambsquarters	100	100	98	98	98	95	—	100	100	100
Morningglory	95	80	90	—	—	—	100	40	98	75
Nutsedge, Yellow	0	0	10	10	15	25	0	0	0	0
Oat, Wild	60	80	35	30	85	70	90	45	90	80
Pigweed	85	100	95	98	98	98	100	98	100	100
Ragweed	80	75	20	60	95	85	95	60	85	45
Ryegrass, Italian	40	20	15	5	35	30	85	30	30	60
Soybean	35	35	65	30	55	60	75	65	100	75
Surinam Grass	55	45	15	20	45	15	60	40	20	60
Velvetleaf	90	85	50	50	85	50	90	65	65	100
Wheat	45	30	30	30	35	20	50	—	35	40
Windgrass	95	50	15	40	80	50	100	85	—	100

	Compounds													
250 g ai/ha	137	138	139	141	142	145	148	153	154	155	156	162	164	166
Postemergence														
Barley	35	60	40	30	45	45	45	—	—	—	—	—	—	—
Barnyardgrass	—	—	—	—	—	—	—	75	40	75	55	95	10	60
Bermudagrass	45	95	80	95	85	90	55	—	—	—	—	—	—	—
Blackgrass	60	45	70	75	90	70	80	90	70	90	85	90	15	60
Bromegrass, Downy	85	65	30	45	50	25	65	—	—	—	—	—	—	—
Canarygrass	75	90	80	80	100	90	95	—	—	—	—	—	—	—
Chickweed	98	98	100	100	98	100	98	95	95	100	98	100	45	90
Cocklebur	60	85	—	—	50	65	—	—	—	—	—	—	—	—
Corn	—	—	60	60	45	50	60	55	20	45	30	40	20	15
Crabgrass, Large	65	95	80	95	95	95	80	90	70	85	70	80	10	40
Cupgrass, Woolly	90	85	—	45	85	75	75	—	—	—	—	—	—	—
Deadnettle	95	100	100	100	100	100	100	—	—	—	—	—	—	—
Foxtail, Giant	50	95	75	80	90	85	75	95	75	100	50	98	35	40
Foxtail, Green	95	90	100	100	100	100	100	—	—	—	—	—	—	—
Galium	70	90	80	90	90	95	90	85	75	95	95	95	60	80
Goosegrass	—	80	80	60	90	80	40	—	—	—	—	—	—	—
Johnsongrass	90	95	80	15	80	75	98	90	85	98	85	98	10	20
Kochia	90	98	90	90	95	95	95	90	95	95	95	95	90	90
Lambsquarters	100	100	98	98	98	95	98	95	98	98	98	98	70	98
Morningglory	90	98	70	—	80	98	98	95	98	98	100	—	75	65
Nutsedge, Yellow	15	20	25	15	20	15	15	15	15	20	10	10	10	10
Oat, Wild	70	98	80	70	70	80	90	85	65	90	70	90	10	30
Oilseed Rape	—	—	—	—	—	—	—	95	95	95	95	95	25	40
Pigweed	100	100	98	98	98	98	98	98	98	100	100	95	80	98
Ragweed	85	85	75	85	75	70	85	85	40	85	80	95	60	75
Ryegrass, Italian	90	75	40	70	50	50	65	65	35	70	70	80	5	25
Soybean	60	80	45	65	55	60	90	85	75	80	95	95	50	35
Surinam Grass	45	—	40	30	50	75	30	—	—	—	—	—	—	—
Velvetleaf	70	90	75	60	75	60	85	95	65	80	80	85	40	30
Waterhemp	—	—	—	—	—	—	—	98	98	98	98	100	75	98
Wheat	35	35	40	20	45	40	40	30	30	40	30	25	10	10
Windgrass	90	80	—	60	95	90	100	—	—	—	—	—	—	—

	Compounds										
250 g ai/ha	168	169	170	171	172	179	183	185	188	195	196
Postemergence											
Barley	—	—	—	—	—	—	—	—	—	35	50
Barnyardgrass	95	85	95	75	90	75	85	80	100	—	—
Bermudagrass	—	—	—	—	—	—	—	—	—	95	90
Blackgrass	80	50	70	30	60	60	60	50	90	80	80
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	60	80
Canarygrass	—	—	—	—	—	—	—	—	—	100	90
Chickweed	100	100	95	100	90	95	98	95	95	98	100
Cocklebur	—	—	—	—	—	—	—	—	—	50	75
Corn	45	30	30	15	30	15	30	25	35	80	65
Crabgrass, Large	95	80	90	55	95	80	85	80	95	95	95

TABLE C-continued

Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	75	90
Deadnettle	—	—	—	—	—	—	—	—	—	100	100
Foxtail, Giant	95	90	98	70	95	80	85	98	100	90	90
Foxtail, Green	—	—	—	—	—	—	—	—	—	100	100
Galium	95	95	90	80	90	90	90	90	90	95	95
Goosegrass	—	—	—	—	—	—	—	—	—	80	85
Johnsongrass	75	50	98	25	95	55	75	75	98	95	95
Kochia	90	90	90	90	90	90	95	90	90	95	90
Lambsquarters	95	98	98	95	98	90	98	95	98	95	95
Morningglory	90	100	100	—	80	90	100	100	—	95	75
Nutsedge, Yellow	20	10	10	10	15	10	10	15	15	25	20
Oat, Wild	60	50	90	20	80	50	85	60	90	85	90
Oilseed Rape	95	60	85	30	95	90	50	55	95	—	—
Pigweed	98	100	100	98	98	100	100	100	100	98	98
Ragweed	80	95	90	55	80	75	95	95	85	85	90
Ryegrass, Italian	80	40	70	10	40	40	40	35	90	60	85
Soybean	60	55	—	—	60	45	90	55	55	65	70
Surinam Grass	—	—	—	—	—	—	—	—	—	60	75
Velvetleaf	90	80	90	75	80	75	75	90	70	65	80
Waterhemp	95	95	100	98	98	95	100	100	100	—	—
Wheat	45	30	35	20	30	15	30	20	50	30	45
Windgrass	—	—	—	—	—	—	—	—	—	100	95

	Compounds											
125 g ai/ha	14	15	16	23	25	26	28	47	106	120	124	129
Postemergence												
Barley	50	50	45	20	30	30	20	50	35	40	30	45
Bermudagrass	55	35	15	15	25	30	20	55	55	5	60	60
Blackgrass	60	80	40	20	40	70	55	60	45	60	85	70
Bromegrass, Downy	40	40	25	5	5	40	35	50	40	30	0	40
Canarygrass	85	85	60	15	30	90	60	85	70	60	85	50
Chickweed	75	75	100	60	98	100	95	—	95	100	55	80
Cocklebur	45	75	45	40	20	55	20	70	40	65	55	15
Corn	15	35	15	20	20	20	25	15	15	10	25	40
Crabgrass, Large	45	60	20	25	40	40	20	35	65	25	45	65
Cupgrass, Woolly	35	75	65	15	25	45	35	80	45	40	20	65
Deadnettle	100	100	98	85	90	98	90	100	90	100	98	100
Foxtail, Giant	30	75	50	15	55	45	35	80	55	50	45	30
Foxtail, Green	90	85	98	45	35	70	70	100	70	100	95	95
Galium	80	80	80	90	55	75	70	95	80	85	85	90
Goosegrass	60	65	10	15	25	40	25	70	45	10	65	30
Johnsongrass	55	80	45	10	10	25	5	35	40	25	45	15
Kochia	95	95	98	80	90	95	75	—	85	98	85	98
Lambsquarters	100	100	100	98	98	98	95	—	100	100	98	98
Morningglory	80	90	75	90	—	—	—	100	40	65	40	65
Nutsedge, Yellow	0	0	0	10	10	15	15	0	0	0	0	0
Oat, Wild	50	60	20	35	30	40	40	85	45	80	35	50
Pigweed	80	90	100	80	95	80	55	100	98	98	98	98
Ragweed	60	70	75	20	60	90	—	75	60	80	65	45
Ryegrass, Italian	35	60	20	10	5	30	25	75	20	5	65	30
Soybean	30	45	35	55	30	50	35	75	60	55	60	70
Surinam Grass	30	50	10	10	20	25	15	60	35	20	20	50
Velvetleaf	85	90	65	40	45	55	35	80	65	55	55	80
Wheat	40	35	25	15	30	30	10	45	30	35	20	30
Windgrass	95	90	50	15	40	80	50	85	80	90	98	85

	Compounds													
125 g ai/ha	137	138	139	141	142	145	148	153	154	155	156	160	162	164
Postemergence														
Barley	30	35	35	15	40	35	40	—	—	—	—	—	—	—
Barnyardgrass	—	—	—	—	—	—	—	45	25	55	40	35	90	10
Bermudagrass	—	75	55	55	75	75	50	—	—	—	—	—	—	—
Blackgrass	35	40	70	35	80	70	70	70	55	85	75	65	85	15
Bromegrass, Downy	60	50	15	30	45	20	60	—	—	—	—	—	—	—
Canarygrass	70	70	60	50	85	50	95	—	—	—	—	—	—	—
Chickweed	98	95	98	98	98	98	90	95	95	95	95	98	100	45
Cocklebur	—	85	—	—	40	65	98	—	—	—	—	—	—	—
Corn	—	—	55	55	35	—	55	45	—	45	25	25	30	20
Crabgrass, Large	40	55	55	80	95	85	60	80	45	75	40	40	35	10
Cupgrass, Woolly	55	55	50	30	75	40	65	—	—	—	—	—	—	—
Deadnettle	95	100	98	100	100	100	100	—	—	—	—	—	—	—
Foxtail, Giant	—	55	40	45	80	50	35	90	55	75	25	75	65	20
Foxtail, Green	95	90	100	100	100	100	100	—	—	—	—	—	—	—
Galium	70	—	80	90	90	90	90	85	70	80	90	95	80	60

TABLE C-continued

Goosegrass	65	50	60	50	70	70	25	—	—	—	—	—	—	—
Johnsongrass	80	45	80	15	80	70	55	60	65	98	65	30	80	10
Kochia	90	98	90	90	95	90	85	90	90	95	90	95	95	40
Lambsquarters	100	100	95	98	98	95	98	95	98	98	98	95	98	60
Morningglory	80	98	60	95	60	95	98	95	75	65	75	98	—	—
Nutsedge, Yellow	10	15	10	15	15	15	15	15	15	10	10	15	5	5
Oat, Wild	50	80	60	45	70	60	80	70	65	75	50	60	60	5
Oilseed Rape	—	—	—	—	—	—	—	90	95	95	95	95	90	20
Pigweed	100	98	98	98	98	98	98	98	98	98	95	98	90	80
Ragweed	75	85	45	—	75	70	85	80	30	85	75	40	85	—
Ryegrass, Italian	65	60	30	50	50	40	60	60	30	65	35	45	60	5
Soybean	55	80	45	55	55	55	80	70	65	80	95	30	75	—
Surinam Grass	45	65	35	30	45	60	25	—	—	—	—	—	—	—
Velvetleaf	55	80	70	60	55	50	80	65	55	75	60	75	60	40
Waterhemp	—	—	—	—	—	—	—	98	98	98	98	98	100	65
Wheat	30	35	40	20	40	30	40	30	20	35	25	25	25	10
Windgrass	70	55	80	55	85	90	98	—	—	—	—	—	—	—

	Compounds											
125 g ai/ha	166	168	169	170	171	172	179	183	185	188	195	196
Postemergence												
Barley	—	—	—	—	—	—	—	—	—	—	35	45
Barnyardgrass	45	90	75	85	60	85	65	80	70	98	—	—
Bermudagrass	—	—	—	—	—	—	—	—	—	—	90	85
Blackgrass	40	80	35	60	10	60	55	60	50	85	80	80
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	—	50	70
Canarygrass	—	—	—	—	—	—	—	—	—	—	85	90
Chickweed	90	90	95	—	95	90	85	80	95	90	98	100
Cocklebur	—	—	—	—	—	—	—	—	—	—	—	65
Corn	15	30	20	30	15	25	15	—	25	20	—	65
Crabgrass, Large	20	95	40	80	40	65	35	35	60	95	90	85
Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	—	75	85
Deadnettle	—	—	—	—	—	—	—	—	—	—	100	100
Foxtail, Giant	40	95	65	98	55	80	55	65	90	98	75	90
Foxtail, Green	—	—	—	—	—	—	—	—	—	—	100	100
Galium	60	90	90	90	80	90	90	90	90	85	95	90
Goosegrass	—	—	—	—	—	—	—	—	—	—	60	80
Johnsongrass	20	70	35	80	25	65	20	50	65	95	95	90
Kochia	90	90	90	90	90	90	90	90	90	90	90	90
Lambsquarters	95	95	98	95	95	98	85	95	85	98	95	95
Morningglory	35	90	100	100	98	—	80	100	100	100	90	75
Nutsedge, Yellow	5	15	10	5	10	15	10	10	10	10	25	15
Oat, Wild	—	50	30	85	10	45	35	55	55	60	80	85
Oilseed Rape	5	90	40	50	30	90	90	25	50	90	—	—
Pigweed	95	98	100	100	90	98	98	100	100	98	98	98
Ragweed	25	65	85	90	55	80	60	90	95	85	70	90
Ryegrass, Italian	20	60	25	35	10	35	25	20	25	85	60	85
Soybean	35	60	50	90	40	60	45	55	45	50	65	65
Surinam Grass	—	—	—	—	—	—	—	—	—	—	—	70
Velvetleaf	20	80	75	85	45	75	75	75	85	70	60	75
Waterhemp	98	95	80	98	75	98	95	100	95	100	—	—
Wheat	5	35	30	35	20	25	15	20	15	45	25	45
Windgrass	—	—	—	—	—	—	—	—	—	—	95	95

	Compounds											
62 g ai/ha	14	15	16	23	25	26	28	47	106	120	124	129
Postemergence												
Barley	35	35	35	15	25	30	15	45	25	30	30	35
Bermudagrass	15	15	5	10	20	20	15	20	40	5	45	45
Blackgrass	40	60	25	20	35	35	10	45	40	30	50	60
Bromegrass, Downy	40	35	15	5	5	30	25	30	35	15	0	35
Canarygrass	80	85	60	10	10	45	50	75	50	35	35	45
Chickweed	75	70	98	55	60	98	55	—	70	100	55	45
Cocklebur	5	60	45	25	20	15	15	65	35	50	20	10
Corn	10	15	15	15	20	20	20	15	15	10	25	15
Crabgrass, Large	45	45	5	15	20	30	15	15	55	25	40	45
Cupgrass, Woolly	5	5	20	10	25	40	30	65	45	10	10	65
Deadnettle	98	100	98	80	55	98	80	100	80	100	98	100
Foxtail, Giant	15	10	40	15	45	30	35	65	40	45	25	20
Foxtail, Green	—	85	98	30	35	40	70	98	50	85	90	95
Galium	80	55	65	85	50	55	55	80	65	80	80	85
Goosegrass	5	40	5	10	20	30	20	35	35	5	55	25
Johnsongrass	20	60	0	10	5	15	5	10	15	5	40	15
Kochia	95	95	98	75	80	95	65	—	85	95	80	95

TABLE C-continued

Lambsquarters	100	100	100	40	80	95	35	—	100	100	98	98
Morningglory	80	75	75	70	—	—	—	95	20	60	40	55
Nutsedge, Yellow	0	0	0	10	5	10	5	0	0	0	0	0
Oat, Wild	45	55	10	10	5	30	15	—	30	60	25	35
Pigweed	60	70	95	—	95	60	55	100	98	98	95	98
Ragweed	55	60	25	10	50	55	60	65	55	60	65	40
Ryegrass, Italian	35	45	10	10	5	20	25	65	5	5	35	15
Soybean	25	35	25	55	30	40	35	70	15	25	55	40
Surinam Grass	5	15	5	10	15	20	10	10	25	5	15	45
Velvetleaf	80	60	65	25	15	50	25	70	45	45	50	45
Wheat	35	35	20	10	20	20	10	35	30	10	15	25
Windgrass	90	85	50	15	35	55	45	80	65	55	95	80

	Compounds													
62 g ai/ha	137	138	139	141	142	145	148	153	154	155	156	160	162	164
Postemergence														
Barley	10	30	10	10	35	20	35	—	—	—	—	—	—	—
Barnyardgrass	—	—	—	—	—	—	—	35	25	35	30	30	65	10
Bermudagrass	30	45	40	—	70	40	30	—	—	—	—	—	—	—
Blackgrass	30	40	40	20	60	60	50	60	35	70	60	45	80	5
Bromegrass, Downy	30	45	10	30	45	10	55	—	—	—	—	—	—	—
Canarygrass	60	55	45	25	80	40	60	—	—	—	—	—	—	—
Chickweed	80	80	98	90	98	85	75	95	85	70	95	95	100	40
Cocklebur	50	70	—	—	30	15	98	—	—	—	—	—	—	—
Corn	—	—	25	45	35	45	30	25	20	25	15	20	30	15
Crabgrass, Large	40	50	45	55	80	50	60	55	30	45	30	35	35	5
Cupgrass, Woolly	50	55	30	20	40	25	55	—	—	—	—	—	—	—
Deadnettle	95	100	95	100	100	100	95	—	—	—	—	—	—	—
Foxtail, Giant	40	55	30	20	75	20	35	80	20	45	15	—	55	20
Foxtail, Green	85	85	95	100	100	100	98	—	—	—	—	—	—	—
Galium	70	90	70	85	80	80	90	65	60	75	90	85	75	30
Goosegrass	25	25	40	40	35	35	15	—	—	—	—	—	—	—
Johnsongrass	40	45	50	10	70	20	20	—	30	80	50	—	80	10
Kochia	90	95	85	90	90	85	85	90	90	90	90	95	90	40
Lambsquarters	100	100	95	98	98	95	98	95	98	95	98	95	95	55
Morningglory	60	90	60	85	—	90	98	80	75	65	70	98	—	60
Nutsedge, Yellow	10	10	10	10	5	10	10	10	10	10	10	10	5	5
Oat, Wild	50	60	50	15	45	40	45	50	35	45	50	45	60	5
Oilseed Rape	—	—	—	—	—	—	—	90	90	90	90	95	90	5
Pigweed	100	98	98	95	98	98	98	95	95	90	90	98	85	75
Ragweed	—	80	40	70	70	—	85	55	30	—	75	40	—	50
Ryegrass, Italian	55	55	30	30	40	30	35	35	10	45	35	30	35	5
Soybean	55	70	40	55	55	50	45	70	60	75	80	25	70	40
Surinam Grass	45	50	35	15	40	30	20	—	—	—	—	—	—	—
Velvetleaf	55	75	35	55	50	35	50	60	45	60	50	50	55	30
Waterhemp	—	—	—	—	—	—	—	98	98	98	98	98	100	65
Wheat	15	10	10	15	25	15	25	30	15	30	15	25	20	10
Windgrass	50	50	70	50	80	70	80	—	—	—	—	—	—	—

	Compounds											
62 g ai/ha	166	168	169	170	171	172	179	183	185	188	195	196
Postemergence												
Barley	—	—	—	—	—	—	—	—	—	—	20	40
Barnyardgrass	25	75	25	55	15	45	45	35	35	95	—	—
Bermudagrass	—	—	—	—	—	—	—	—	—	—	60	80
Blackgrass	20	45	15	10	10	25	50	20	40	55	70	80
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	—	30	50
Canarygrass	—	—	—	—	—	—	—	—	—	—	60	90
Chickweed	90	80	60	95	70	85	80	75	85	90	95	98
Cocklebur	—	—	—	—	—	—	—	—	—	—	—	60
Corn	15	15	15	25	15	20	15	20	20	20	75	60
Crabgrass, Large	15	65	35	30	20	55	20	35	40	85	60	85
Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	—	65	80
Deadnettle	—	—	—	—	—	—	—	—	—	—	100	100
Foxtail, Giant	40	65	65	80	35	35	40	45	80	98	35	85
Foxtail, Green	—	—	—	—	—	—	—	—	—	—	100	100
Galium	50	90	90	90	75	90	90	70	80	80	95	85
Goosegrass	—	—	—	—	—	—	—	—	—	—	50	75
Johnsongrass	15	55	30	25	15	60	20	30	30	75	80	90
Kochia	90	90	90	90	90	90	90	90	90	90	85	90
Lambsquarters	95	95	90	95	75	98	80	95	80	95	95	95
Morningglory	30	80	—	98	65	80	80	98	98	100	90	75
Nutsedge, Yellow	5	10	5	5	5	10	5	10	10	10	20	10
Oat, Wild	20	45	25	65	5	20	20	40	30	60	75	85

TABLE C-continued

Oilseed Rape	5	70	40	50	20	90	40	25	50	90	—	—
Pigweed	85	98	95	100	90	98	98	—	98	95	95	98
Ragweed	15	65	60	85	55	75	55	80	90	75	50	85
Ryegrass, Italian	5	35	10	35	5	20	15	15	10	70	55	60
Soybean	35	35	30	70	35	45	35	55	45	50	40	50
Surinam Grass	—	—	—	—	—	—	—	—	—	—	50	70
Velvetleaf	20	75	65	85	25	65	75	—	80	65	50	65
Waterhemp	—	90	80	98	75	95	90	100	90	100	—	—
Wheat	5	20	10	20	10	20	10	20	15	30	20	35
Windgrass	—	—	—	—	—	—	—	—	—	—	80	80

	Compounds											
31 g ai/ha	14	15	16	23	25	26	28	47	106	120	124	129
Postemergence												
Barley	30	35	115	5	20	20	10	35	15	20	15	30
Bermudagrass	0	5	5	5	15	20	10	10	40	5	25	40
Blackgrass	15	30	10	15	10	30	10	40	30	25	35	40
Bromegrass, Downy	30	25	15	5	5	15	5	10	30	15	0	35
Canarygrass	55	60	20	5	5	40	30	60	35	25	20	30
Chickweed	60	55	85	30	30	40	30	80	60	75	50	15
Cocklebur	5	5	35	25	15	10	10	10	35	45	15	5
Corn	5	5	5	10	20	20	15	5	10	5	20	10
Crabgrass, Large	10	15	5	10	15	20	10	5	40	5	30	20
Cupgrass, Woolly	5	5	5	10	25	25	20	55	5	10	5	35
Deadnettle	98	100	50	80	50	98	40	95	75	100	80	100
Foxtail, Giant	10	10	40	15	35	25	35	65	40	5	15	0
Foxtail, Green	70	40	30	—	35	30	30	20	50	15	70	85
Galium	60	55	60	85	50	50	40	80	65	80	70	60
Goosegrass	5	25	5	10	15	25	20	5	10	5	45	15
Johnsongrass	20	45	0	5	5	15	5	0	0	0	5	5
Kochia	90	95	95	65	75	75	40	65	85	65	80	95
Lambsquarters	100	100	95	40	70	80	35	100	80	100	95	98
Morningglory	75	75	50	70	—	—	—	75	0	60	15	50
Nutsedge, Yellow	0	0	0	10	5	10	5	0	0	0	0	0
Oat, Wild	25	45	5	5	5	10	10	35	10	55	20	20
Pigweed	45	60	75	70	85	—	55	100	95	95	90	85
Ragweed	55	60	5	10	50	40	35	45	10	60	50	40
Ryegrass, Italian	30	30	10	5	5	10	10	35	5	5	15	5
Soybean	25	10	20	30	25	35	30	40	10	25	55	20
Surinam Grass	5	10	5	5	10	15	5	5	20	5	10	45
Velvetleaf	75	60	10	15	15	25	20	65	5	20	45	45
Wheat	30	25	5	10	10	10	5	15	10	10	10	20
Windgrass	70	20	45	10	30	40	30	60	50	50	80	60

	Compounds													
31 g ai/ha	137	138	139	141	142	145	148	153	154	155	156	160	162	164
Postemergence														
Barley	10	10	5	5	20	15	35	—	—	—	—	—	—	—
Barnyardgrass	—	—	—	—	—	—	—	20	15	25	20	20	20	5
Bermudagrass	30	20	35	15	15	10	10	—	—	—	—	—	—	—
Blackgrass	10	20	35	20	55	10	40	55	15	40	50	35	45	5
Bromegrass, Downy	10	40	5	25	25	5	45	—	—	—	—	—	—	—
Canarygrass	45	30	40	20	45	15	40	—	—	—	—	—	—	—
Chickweed	70	—	75	80	85	75	75	95	85	50	95	90	100	10
Cocklebur	45	65	—	5	—	10	85	—	—	—	—	—	—	—
Corn	—	—	—	45	30	35	25	20	20	25	—	15	15	15
Crabgrass, Large	15	45	40	20	65	25	15	50	20	20	10	25	20	5
Cupgrass, Woolly	45	50	15	15	40	20	55	—	—	—	—	—	—	—
Deadnettle	80	98	95	100	100	100	95	—	—	—	—	—	—	—
Foxtail, Giant	10	20	15	10	20	15	10	45	20	15	10	20	45	10
Foxtail, Green	80	35	95	100	100	98	80	—	—	—	—	—	—	—
Galium	45	85	60	85	80	80	80	60	45	70	80	80	75	30
Goosegrass	20	5	15	35	35	25	—	—	—	—	—	—	—	—
Johnsongrass	5	45	30	10	55	10	20	40	10	20	45	15	45	10
Kochia	90	95	85	85	80	85	80	90	90	90	90	90	90	40
Lambsquarters	100	100	90	98	80	95	98	95	75	80	98	80	95	50
Morningglory	—	90	55	85	60	90	70	40	40	55	65	60	—	50
Nutsedge, Yellow	5	10	10	0	5	5	10	10	10	5	5	10	5	0
Oat, Wild	45	55	40	10	35	20	15	35	15	40	35	30	40	5
Oilseed Rape	—	—	—	—	—	—	—	90	80	90	80	95	90	5
Pigweed	98	98	95	95	98	85	65	95	95	90	75	95	85	50
Ragweed	65	75	—	60	65	60	65	55	30	80	75	10	85	50
Ryegrass, Italian	35	40	25	15	10	20	10	30	5	35	15	30	30	5
Soybean	40	55	40	40	50	50	45	55	45	50	55	25	70	30

TABLE C-continued

Surinam Grass	40	45	10	15	40	25	20	—	—	—	—	—	—	—
Velvetleaf	35	50	20	40	30	35	50	50	35	50	45	30	35	25
Waterhemp	—	—	—	—	—	—	—	98	90	98	98	95	98	35
Wheat	10	10	10	10	15	5	20	10	10	15	5	5	20	5
Windgrass	40	50	50	50	80	50	60	—	—	—	—	—	—	—

	Compounds											
31 g ai/ha	166	168	169	170	171	172	179	183	185	188	195	196
Postemergence												
Barley	—	—	—	—	—	—	—	—	—	—	15	30
Barnyardgrass	10	40	15	20	10	40	40	15	30	75	—	—
Bermudagrass	—	—	—	—	—	—	—	—	—	—	40	80
Blackgrass	10	45	5	10	5	10	30	10	20	55	45	70
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	—	15	50
Canarygrass	—	—	—	—	—	—	—	—	—	—	40	80
Chickweed	55	80	60	75	50	65	75	75	70	80	95	98
Cocklebur	—	—	—	—	—	—	—	—	—	—	—	55
Corn	15	15	10	15	15	20	15	10	15	10	60	60
Crabgrass, Large	15	30	35	30	15	20	20	25	25	50	55	80
Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	—	50	30
Deadnettle	—	—	—	—	—	—	—	—	—	—	100	100
Foxtail, Giant	20	55	20	55	25	35	35	45	40	98	35	85
Foxtail, Green	—	—	—	—	—	—	—	—	—	—	100	100
Galium	50	90	80	80	70	90	90	70	70	60	80	80
Goosegrass	—	—	—	—	—	—	—	—	—	—	50	75
Johnsongrass	10	30	15	20	15	35	10	20	10	45	55	80
Kochia	90	90	85	90	90	90	80	90	90	70	75	85
Lambsquarters	60	80	90	85	75	98	80	85	80	90	95	95
Morningglory	30	50	98	75	60	65	65	98	90	70	65	75
Nutsedge, Yellow	0	10	5	5	5	10	5	10	10	10	10	10
Oat, Wild	15	30	5	30	5	15	10	30	25	45	60	55
Oilseed Rape	5	40	30	30	5	50	30	20	10	40	—	—
Pigweed	35	80	95	100	70	98	95	100	98	95	95	98
Ragweed	15	65	40	85	55	75	50	65	75	65	—	70
Ryegrass, Italian	5	10	10	15	5	10	10	10	10	50	25	35
Soybean	35	30	30	30	25	35	30	35	40	40	40	45
Surinam Grass	—	—	—	—	—	—	—	—	—	—	30	35
Velvetleaf	10	60	50	75	25	65	55	75	55	50	45	55
Waterhemp	90	80	75	85	70	90	80	85	90	70	—	—
Wheat	5	20	10	10	5	10	5	10	5	20	10	15
Windgrass	—	—	—	—	—	—	—	—	—	—	55	80

	Compounds			Compounds	
16 g ai/ha	15	124	16 g ai/ha	15	124
Postemergence					
Barley	30	5	Goosegrass	5	25
Bermudagrass	5	5	Johnsongrass	0	5
Blackgrass	20	0	Kochia	90	75
Bromegrass, Downy	10	0	Lambsquarters	100	85
Canarygrass	35	0	Morningglory	45	15
Chickweed	55	45	Nutsedge, Yellow	0	0
Cocklebur	—	10	Oat, Wild	40	20
Corn	0	5	Pigweed	5	75
Crabgrass, Large	5	20	Ragweed	45	45
Cupgrass, Woolly	5	5	Ryegrass, Italian	10	5
Deadnettle	90	75	Soybean	10	45
Foxtail, Giant	5	15	Surinam Grass	5	5
Foxtail, Green	30	65	Velvetleaf	60	45
Galium	50	70	Wheat	15	5
Goosegrass	5	25	Windgrass	20	50

16 g ai/ha	Compound 160	16 g ai/ha	Compound 160
Postemergence			
Barnyardgrass	15	Nutsedge, Yellow	5
Blackgrass	25	Oat, Wild	15
Chickweed	70	Oilseed Rape	85
Corn	15	Pigweed	95
Crabgrass, Large	20	Ragweed	10
Foxtail, Giant	15	Ryegrass, Italian	10
Galium	55	Soybean	15
Johnsongrass	10	Velvetleaf	20

TABLE C-continued

Kochia	90	Waterhemp	95
Lambsquarters	70	Wheat	5
Morningglory	60		

	Compounds								
250 g ai/ha	14	16	23	25	26	47	106	120	129
Preemergence									
Bermudagrass	100	75	100	100	100	100	100	100	98
Blackgrass	98	100	100	100	90	100	95	90	90
Bromegrass, Downy	98	100	10	80	85	100	60	90	100
Cocklebur	45	—	5	30	55	5	—	5	0
Corn	10	—	85	10	5	40	10	50	65
Crabgrass, Large	100	—	100	100	100	100	100	100	100
Cupgrass, Woolly	80	—	100	98	90	98	90	98	98
Foxtail, Giant	100	—	100	100	100	100	100	100	98
Foxtail, Green	100	100	100	95	95	100	95	90	90
Galium	100	100	100	98	100	100	90	100	100
Goosegrass	100	—	100	100	100	100	100	98	98
Johnsongrass	85	—	98	98	98	95	85	98	95
Kochia	85	—	100	85	98	98	65	100	95
Lambsquarters	100	—	100	98	100	100	100	100	100
Morningglory	65	—	100	—	—	65	60	90	65
Nightshade	98	—	98	95	98	98	100	95	95
Nutsedge, Yellow	0	—	55	0	0	0	0	0	5
Oat, Wild	90	100	100	90	95	100	80	95	95
Pigweed	100	—	100	100	100	100	100	100	100
Ragweed	—	—	60	50	75	80	55	65	55
Russian Thistle	95	100	—	90	95	100	100	100	—
Ryegrass, Italian	85	100	70	90	80	98	50	95	95
Soybean	0	—	50	10	15	35	5	20	40
Sunflower	15	—	0	0	15	10	0	5	0
Surinam Grass	85	—	100	100	90	65	90	100	98
Velvetleaf	75	—	100	70	100	100	10	100	95
Wheat	45	45	35	35	30	40	5	50	60

	Compounds													
250 g ai/ha	138	139	142	145	146	147	148	153	154	155	156	162	163	164
Preemergence														
Barnyardgrass	—	—	—	—	—	—	—	100	100	100	100	100	100	70
Bermudagrass	100	100	98	98	98	100	100	—	—	—	—	—	—	—
Blackgrass	95	90	90	90	90	90	90	90	90	90	90	95	95	70
Bromegrass, Downy	80	85	90	85	80	90	80	—	—	—	—	—	—	—
Cocklebur	15	5	—	—	0	—	—	—	—	—	—	—	—	—
Corn	55	30	30	60	25	35	45	35	15	45	30	35	10	10
Crabgrass, Large	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cupgrass, Woolly	100	90	98	98	100	98	98	—	—	—	—	—	—	—
Foxtail, Giant	100	100	100	100	100	100	100	100	100	100	95	100	100	100
Foxtail, Green	95	90	90	90	90	95	95	—	—	—	—	—	—	—
Galium	100	95	100	100	100	100	100	100	100	100	100	100	75	80
Goosegrass	100	100	100	100	100	100	100	—	—	—	—	—	—	—
Johnsongrass	100	100	100	100	100	98	98	98	95	95	95	98	60	40
Kochia	90	100	100	98	85	85	95	—	—	—	—	—	—	—
Lambsquarters	98	90	98	98	95	80	85	100	100	100	100	—	—	95
Morningglory	98	55	—	85	90	35	75	50	25	90	30	85	75	45
Nightshade	98	98	98	90	98	98	85	—	—	—	—	—	—	—
Nutsedge, Yellow	5	5	0	10	10	15	—	—	—	—	0	5	75	0
Oat, Wild	95	85	90	90	90	95	85	—	—	—	—	—	—	—
Oilseed Rape	—	—	—	—	—	—	—	98	100	100	98	100	95	30
Pigweed	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Ragweed	50	55	80	55	45	80	70	80	70	95	60	95	35	30
Russian Thistle	100	5	90	95	95	90	95	—	—	—	—	—	—	—
Ryegrass, Italian	90	90	90	90	90	95	90	90	90	90	90	95	85	75
Soybean	30	25	20	10	40	35	30	35	15	40	25	25	20	5
Sunflower	30	10	25	25	35	25	10	—	—	—	—	—	—	—
Surinam Grass	100	98	98	100	100	95	100	—	—	—	—	—	—	—
Velvetleaf	98	40	100	85	60	100	80	100	100	100	100	100	75	70

TABLE C-continued

Waterhemp	—	—	—	—	—	—	—	100	100	100	100	100	100	—
Wheat	50	20	50	50	10	45	35	60	55	35	35	35	0	5

	Compounds												
250 g ai/ha	166	168	169	170	171	172	174	179	183	185	188	195	196
Preemergence													
Barnyardgrass	100	100	100	100	98	100	98	100	100	100	100	—	—
Bermudagrass	—	—	—	—	—	—	—	—	—	—	—	98	100
Blackgrass	95	98	95	100	100	95	100	100	100	98	100	90	90
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	—	—	90	100
Cocklebur	—	—	—	—	—	—	—	—	—	—	—	—	75
Corn	20	55	20	60	25	40	10	20	40	35	20	35	50
Crabgrass, Large	100	100	100	100	100	100	100	100	100	100	100	100	100
Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	—	—	98	100
Foxtail, Giant	100	100	100	100	100	100	100	100	100	100	100	100	100
Foxtail, Green	—	—	—	—	—	—	—	—	—	—	—	90	90
Galium	100	100	100	100	100	100	100	100	100	100	95	95	100
Goosegrass	—	—	—	—	—	—	—	—	—	—	—	100	100
Johnsongrass	100	100	98	95	95	98	95	100	95	100	98	100	100
Kochia	—	—	—	—	—	—	—	—	—	—	—	95	98
Lambsquarters	—	98	90	98	100	95	90	100	100	100	100	95	95
Morningglory	45	80	85	100	25	70	55	65	95	100	100	90	100
Nightshade	—	—	—	—	—	—	—	—	—	—	—	98	100
Nutsedge, Yellow	15	5	5	5	0	5	0	5	5	5	20	80	10
Oat, Wild	—	—	—	—	—	—	—	—	—	—	—	90	90
Oilseed Rape	100	100	100	100	90	100	50	100	100	100	100	—	—
Pigweed	100	100	100	100	100	100	100	100	100	100	100	100	98
Ragweed	55	80	65	95	15	85	55	45	95	95	—	55	90
Russian Thistle	—	—	—	—	—	—	—	—	—	—	—	90	90
Ryegrass, Italian	100	100	95	95	100	100	95	95	95	100	98	90	90
Soybean	35	35	30	45	—	35	10	25	30	40	65	25	35
Sunflower	—	—	—	—	—	—	—	—	—	—	—	20	40
Surinam Grass	—	—	—	—	—	—	—	—	—	—	—	98	100
Velvetleaf	60	100	100	100	65	100	100	80	100	100	90	90	100
Waterhemp	100	—	—	—	—	—	—	—	—	—	100	—	—
Wheat	15	60	50	60	45	45	40	55	40	55	40	30	50

	Compounds									
125 g ai/ha	14	15	16	23	25	26	47	106	120	129
Preemergence										
Bermudagrass	100	100	75	100	98	100	100	100	98	98
Blackgrass	85	95	100	100	95	90	100	90	90	90
Bromegrass, Downy	60	80	50	5	40	50	90	40	90	95
Cocklebur	20	65	—	5	0	15	0	—	—	0
Corn	5	10	—	70	5	5	10	0	25	45
Crabgrass, Large	100	100	—	100	100	100	100	100	100	100
Cupgrass, Woolly	75	95	—	100	65	70	95	80	98	98
Foxtail, Giant	100	100	—	100	100	100	100	100	98	98
Foxtail, Green	100	100	100	100	95	95	100	95	90	90
Galium	100	98	100	100	80	100	100	60	100	100
Goosegrass	100	100	—	100	100	100	100	98	98	98
Johnsongrass	80	90	—	95	65	95	60	75	95	85
Kochia	75	85	—	95	55	95	98	45	100	90
Lambsquarters	100	100	—	98	98	98	100	100	100	98
Morningglory	55	45	—	100	—	—	50	10	45	60
Nightshade	95	90	—	95	95	98	98	90	95	90
Nutsedge, Yellow	0	10	—	35	0	0	0	0	0	0
Oat, Wild	70	70	100	80	80	70	90	70	95	95
Pigweed	100	100	—	100	100	100	100	100	100	100
Ragweed	—	—	—	20	20	50	45	0	45	0
Russian Thistle	95	100	100	—	90	95	100	30	85	—
Ryegrass, Italian	60	80	100	25	45	60	90	45	90	90
Soybean	0	25	—	10	0	5	5	5	10	10
Sunflower	0	25	—	0	0	10	0	0	0	0
Surinam Grass	60	90	—	100	55	65	65	80	98	98

TABLE C-continued

Velvetleaf	70	80	—	80	15	75	90	0	35	45
Wheat	35	50	15	20	10	30	35	0	40	30

	Compounds													
125 g ai/ha	138	139	142	145	146	147	148	153	154	155	156	160	162	163
Preemergence														
Barnyardgrass	—	—	—	—	—	—	—	100	90	98	90	100	100	75
Bermudagrass	100	100	98	98	98	100	100	—	—	—	—	—	—	—
Blackgrass	95	90	90	90	90	90	90	90	90	90	90	90	90	90
Bromegrass, Downy	60	—	90	70	15	85	50	—	—	—	—	—	—	—
Cocklebur	15	0	10	10	0	—	—	—	—	—	—	—	—	—
Corn	40	10	20	25	15	25	15	25	10	10	10	5	20	—
Crabgrass, Large	100	100	100	100	100	100	100	100	100	100	98	100	100	100
Cupgrass, Woolly	95	75	95	95	90	95	95	—	—	—	—	—	—	—
Foxtail, Giant	100	100	100	100	100	100	100	100	100	100	90	100	100	80
Foxtail, Green	95	—	90	90	90	95	95	—	—	—	—	—	—	—
Galium	100	85	100	100	95	100	100	100	85	100	100	100	100	5
Goosegrass	100	100	100	100	100	100	98	—	—	—	—	—	—	—
Johnsongrass	98	100	100	100	98	95	98	95	90	90	90	100	98	60
Kochia	85	90	98	98	85	80	90	—	—	—	—	—	—	—
Lambsquarters	98	85	95	95	85	80	65	100	100	100	100	100	—	—
Morningglory	65	35	—	70	45	—	55	50	5	60	10	20	80	30
Nightshade	98	85	98	85	90	98	85	—	—	—	—	—	—	—
Nutsedge, Yellow	5	0	0	5	—	0	5	5	—	—	0	0	5	20
Oat, Wild	95	—	85	90	85	85	85	—	—	—	—	—	—	—
Oilseed Rape	—	—	—	—	—	—	—	98	90	90	90	80	100	80
Pigweed	100	100	100	98	100	100	100	100	100	100	100	100	100	100
Ragweed	50	30	70	40	45	70	55	80	50	85	30	5	80	20
Russian Thistle	90	—	90	90	80	90	95	—	—	—	—	—	—	—
Ryegrass, Italian	70	—	90	90	55	85	60	90	90	85	90	90	90	65
Soybean	—	25	5	5	—	20	20	35	15	35	25	20	—	10
Sunflower	30	5	15	20	30	15	10	—	—	—	—	—	—	—
Surinam Grass	85	85	98	100	100	95	75	—	—	—	—	—	—	—
Velvetleaf	55	40	80	75	15	60	70	95	90	85	40	30	100	20
Waterhemp	—	—	—	—	—	—	—	100	100	100	100	100	100	100
Wheat	10	10	35	5	0	30	30	60	5	10	20	40	20	0

	Compounds													
125 g ai/ha	164	166	168	169	170	171	172	174	179	183	185	188	189	195
Preemergence														
Barnyardgrass	25	98	100	98	100	95	100	98	100	100	100	100	100	—
Bermudagrass	—	—	—	—	—	—	—	—	—	—	—	—	—	98
Blackgrass	60	90	95	95	100	100	95	85	100	95	95	100	100	90
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	—	—	—	—	85
Cocklebur	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Corn	10	5	25	10	15	5	15	5	20	40	35	10	20	15
Crabgrass, Large	98	100	100	100	100	100	100	100	100	100	100	100	100	100
Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	—	—	—	—	95
Foxtail, Giant	98	100	100	100	100	100	100	100	100	100	100	100	100	100
Foxtail, Green	—	—	—	—	—	—	—	—	—	—	—	—	—	90
Galium	80	90	100	100	100	98	100	80	100	100	100	95	95	90
Goosegrass	—	—	—	—	—	—	—	—	—	—	—	—	—	100
Johnsongrass	20	75	100	95	95	75	95	50	95	80	80	95	85	98
Kochia	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lambsquarters	95	—	98	90	98	—	95	90	98	100	100	98	90	90
Morningglory	25	25	55	80	100	25	55	15	55	70	70	85	60	75
Nightshade	—	—	—	—	—	—	—	—	—	—	—	—	—	95
Nutsedge, Yellow	0	5	5	5	—	0	5	0	0	5	0	5	0	5
Oat, Wild	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oilseed Rape	—	90	100	100	100	50	98	50	100	100	100	100	85	—
Pigweed	90	100	100	100	100	100	100	100	100	100	100	100	100	100
Ragweed	25	25	80	30	75	10	80	55	45	95	95	—	—	20
Russian Thistle	—	—	—	—	—	—	—	—	—	—	—	—	—	90
Ryegrass, Italian	55	50	100	90	95	60	100	90	95	90	100	95	100	90
Soybean	5	20	10	10	20	5	10	10	10	10	40	—	25	0
Sunflower	—	—	—	—	—	—	—	—	—	—	—	—	—	15
Surinam Grass	—	—	—	—	—	—	—	—	—	—	—	—	—	85
Velvetleaf	30	15	100	75	100	55	100	65	80	100	100	85	60	55

TABLE C-continued

Waterhemp	—	100	—	—	—	—	—	—	—	—	—	100	100	—
Wheat	0	5	40	20	60	5	45	20	50	35	40	35	30	5

125 g ai/ha	Compound 196	62 g ai/ha	Compound 196
Preemergence			
Barnyardgrass	—	Barnyardgrass	—
Bermudagrass	100	Bermudagrass	98
Blackgrass	90	Blackgrass	90
Bromegrass, Downy	100	Bromegrass, Downy	95
Cocklebur	45	Cocklebur	—
Corn	45	Corn	35
Crabgrass, Large	100	Crabgrass, Large	100
Cupgrass, Woolly	100	Cupgrass, Woolly	98
Foxtail, Giant	100	Foxtail, Giant	100
Foxtail, Green	90	Foxtail, Green	90
Galium	98	Galium	95
Goosegrass	100	Goosegrass	100
Johnsongrass	—	Johnsongrass	100
Kochia	98	Kochia	98
Lambsquarters	95	Lambsquarters	90
Morningglory	100	Morningglory	85
Nightshade	100	Nightshade	100
Nutsedge, Yellow	5	Nutsedge, Yellow	0
Oat, Wild	90	Oat, Wild	90
Oilseed Rape	—	Oilseed Rape	—
Pigweed	98	Pigweed	98
Ragweed	80	Ragweed	60
Russian Thistle	90	Russian Thistle	90
Ryegrass, Italian	90	Ryegrass, Italian	90
Soybean	30	Soybean	15
Sunflower	30	Sunflower	20
Surinam Grass	100	Surinam Grass	98
Velvetleaf	80	Velvetleaf	70
Waterhemp	—	Waterhemp	—
Wheat	40	Wheat	15

	Compounds									
62 g ai/ha	14	15	16	23	25	26	47	106	120	129
Preemergence										
Bermudagrass	100	100	25	100	98	100	100	100	98	98
Blackgrass	40	85	100	85	85	90	98	50	90	90
Bromegrass, Downy	35	30	10	0	5	45	40	5	85	80
Cocklebur	—	—	—	0	0	5	0	—	0	0
Corn	0	0	—	30	0	5	5	0	5	10
Crabgrass, Large	100	100	—	100	100	98	98	100	100	100
Cupgrass, Woolly	75	85	—	100	40	65	80	60	95	95
Foxtail, Giant	98	100	—	100	100	100	100	85	98	98
Foxtail, Green	100	100	100	100	95	95	100	95	90	90
Galium	90	95	100	95	15	75	100	10	100	100
Goosegrass	100	100	—	100	100	100	100	98	98	98
Johnsongrass	45	85	—	75	30	55	10	20	80	75
Kochia	0	70	—	95	40	95	90	0	90	90
Lambsquarters	100	100	—	98	90	98	100	100	100	95
Morningglory	10	15	—	20	—	—	20	0	45	20
Nightshade	80	85	—	90	45	90	98	75	95	90
Nutsedge, Yellow	0	0	—	10	0	0	0	0	0	0
Oat, Wild	40	70	100	80	30	70	90	45	90	85
Pigweed	100	100	—	100	100	100	100	98	100	100
Ragweed	—	—	—	20	5	35	15	0	45	0
Russian Thistle	90	95	100	—	—	80	100	5	—	—
Ryegrass, Italian	35	45	95	5	35	60	50	20	90	90
Soybean	0	0	—	5	0	5	0	0	5	0
Sunflower	0	0	—	0	0	—	0	0	0	0
Surinam Grass	45	55	—	60	20	50	20	20	95	95

TABLE C-continued

Velvetleaf	10	20	—	25	5	35	60	0	15	10
Wheat	15	25	5	0	5	5	5	0	25	20

	Compounds													
62 g ai/ha	138	139	142	145	146	147	148	153	154	155	156	160	162	163
Preemergence														
Barnyardgrass	—	—	—	—	—	—	—	90	90	90	90	90	100	25
Bermudagrass	100	100	98	98	98	100	100	—	—	—	—	—	—	—
Blackgrass	95	90	90	90	70	85	85	90	90	90	90	90	90	85
Bromegrass, Downy	30	20	60	20	0	45	40	—	—	—	—	—	—	—
Cocklebur	5	0	10	0	0	—	—	—	—	—	—	—	—	—
Corn	30	0	5	10	0	10	10	25	5	5	5	5	20	10
Crabgrass, Large	100	100	100	100	100	100	100	100	100	100	90	100	100	100
Cupgrass, Woolly	90	40	70	90	45	55	90	—	—	—	—	—	—	—
Foxtail, Giant	100	100	100	100	100	98	100	100	100	100	90	100	100	60
Foxtail, Green	95	90	90	90	90	95	95	—	—	—	—	—	—	—
Galium	100	80	80	98	95	100	100	98	85	100	100	100	—	5
Goosegrass	100	100	100	100	85	100	95	—	—	—	—	—	—	—
Johnsongrass	85	45	98	35	75	55	80	90	40	90	90	100	60	35
Kochia	65	75	80	90	55	40	40	—	—	—	—	—	—	—
Lambsquarters	98	70	90	85	40	45	25	100	100	100	100	100	—	—
Morningglory	55	15	35	20	40	30	20	30	5	40	10	15	60	25
Nightshade	95	75	95	80	35	98	60	—	—	—	—	—	—	—
Nutsedge, Yellow	—	0	—	—	0	0	5	0	—	—	0	0	0	0
Oat, Wild	85	50	85	70	40	70	85	—	—	—	—	—	—	—
Oilseed Rape	—	—	—	—	—	—	—	95	90	90	60	80	100	50
Pigweed	100	98	98	98	90	100	100	100	100	100	100	100	100	98
Ragweed	45	0	40	10	0	40	45	10	0	40	10	5	75	10
Russian Thistle	90	—	80	—	0	90	85	—	—	—	—	—	—	—
Ryegrass, Italian	40	60	90	35	30	50	60	90	30	85	80	80	80	45
Soybean	20	15	5	5	15	20	10	20	0	35	10	20	15	5
Sunflower	10	0	—	5	20	15	0	—	—	—	—	—	—	—
Surinam Grass	80	65	75	55	20	80	75	—	—	—	—	—	—	—
Velvetleaf	—	10	75	10	5	55	55	85	45	80	40	30	80	10
Waterhemp	—	—	—	—	—	—	—	100	100	100	100	100	100	100
Wheat	5	0	5	5	0	5	5	35	5	5	5	15	5	0

	Compounds													
62 g ai/ha	164	166	168	169	170	171	172	174	179	183	185	188	189	195
Preemergence														
Barnyardgrass	15	75	100	80	98	75	98	20	100	95	98	100	98	—
Bermudagrass	—	—	—	—	—	—	—	—	—	—	—	—	—	98
Blackgrass	10	90	90	90	95	98	95	80	100	95	95	100	100	90
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	—	—	—	—	45
Cocklebur	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Corn	5	—	15	5	10	0	5	5	20	15	5	5	15	5
Crabgrass, Large	75	98	100	100	100	100	100	98	100	100	100	100	100	100
Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	—	—	—	—	95
Foxtail, Giant	65	100	100	100	100	100	100	85	100	100	100	100	100	98
Foxtail, Green	—	—	—	—	—	—	—	—	—	—	—	—	—	90
Galium	50	10	100	100	100	98	100	50	100	100	100	90	80	80
Goosegrass	—	—	—	—	—	—	—	—	—	—	—	—	—	100
Johnsongrass	15	30	98	75	75	25	75	25	60	35	70	85	85	—
Kochia	—	—	—	—	—	—	—	—	—	—	—	—	—	75
Lambsquarters	85	—	98	90	85	100	90	85	98	100	100	90	90	80
Morningglory	15	10	55	55	55	20	35	5	40	45	55	60	40	50
Nightshade	—	—	—	—	—	—	—	—	—	—	—	—	—	85
Nutsedge, Yellow	0	0	0	5	5	0	5	0	0	0	0	5	0	0
Oat, Wild	—	—	—	—	—	—	—	—	—	—	—	—	—	90
Oilseed Rape	5	50	100	98	95	50	90	5	98	80	85	70	70	—
Pigweed	35	100	100	100	100	100	100	100	100	100	100	100	100	98
Ragweed	20	20	30	15	60	5	40	15	40	50	80	—	—	20
Russian Thistle	—	—	—	—	—	—	—	—	—	—	—	—	—	90
Ryegrass, Italian	10	40	98	90	90	50	100	40	95	80	100	65	85	80
Soybean	0	5	10	5	5	0	10	0	10	5	10	20	15	0
Sunflower	—	—	—	—	—	—	—	—	—	—	—	—	—	15
Surinam Grass	—	—	—	—	—	—	—	—	—	—	—	—	—	75
Velvetleaf	10	0	100	75	100	25	75	15	75	55	80	65	40	25

TABLE C-continued

Waterhemp	—	100	—	—	—	—	—	—	—	—	—	100	100	—
Wheat	0	0	40	15	40	0	40	0	15	10	40	30	15	5

	Compounds									
31 g ai/ha	14	15	16	23	25	26	47	106	120	129
Preemergence										
Bermudagrass	98	100	5	100	85	75	100	100	98	98
Blackgrass	5	50	90	5	60	55	90	50	90	90
Bromegrass, Downy	30	25	5	0	5	5	15	0	45	30
Cocklebur	0	0	—	0	0	0	0	—	0	0
Corn	0	0	—	5	0	0	0	0	0	0
Crabgrass, Large	95	100	—	100	98	98	45	100	100	98
Cupgrass, Woolly	5	45	—	95	20	10	45	5	90	80
Foxtail, Giant	95	95	—	98	98	98	95	65	98	95
Foxtail, Green	80	95	100	100	90	85	100	90	90	90
Galium	20	75	100	80	0	50	85	5	98	85
Goosegrass	98	100	—	95	90	95	98	80	98	98
Johnsongrass	20	55	—	55	5	15	5	0	25	25
Kochia	0	70	—	95	10	45	85	0	10	5
Lambsquarters	95	100	—	95	90	70	100	85	85	95
Morningglory	10	5	—	20	—	—	5	0	45	0
Nightshade	55	25	—	50	10	55	45	0	95	85
Nutsedge, Yellow	0	0	—	5	0	0	0	0	0	0
Oat, Wild	20	40	98	45	20	45	80	10	85	40
Pigweed	100	100	—	100	100	100	100	85	100	100
Ragweed	—	—	—	5	5	15	5	0	0	0
Russian Thistle	10	50	45	—	0	—	85	0	0	—
Ryegrass, Italian	10	40	5	0	5	10	35	5	40	60
Soybean	0	0	—	0	0	0	0	0	0	0
Sunflower	0	0	—	0	0	0	0	—	0	0
Surinam Grass	20	40	—	15	15	10	5	5	65	95
Velvetleaf	10	0	—	5	0	25	45	0	5	0
Wheat	0	10	0	0	0	0	0	0	5	0

	Compounds													
31 g ai/ha	138	139	142	145	146	147	148	153	154	155	156	160	162	163
Preemergence														
Barnyardgrass	—	—	—	—	—	—	—	90	45	40	85	35	98	10
Bermudagrass	100	98	98	98	98	100	98	—	—	—	—	—	—	—
Blackgrass	90	45	90	85	50	50	60	90	90	90	85	40	60	5
Bromegrass, Downy	10	0	20	5	0	10	5	—	—	—	—	—	—	—
Cocklebur	5	—	0	0	0	35	10	—	—	—	—	—	—	—
Corn	20	0	0	0	0	10	5	10	0	5	5	5	5	10
Crabgrass, Large	98	100	100	98	98	98	100	100	90	100	90	100	100	65
Cupgrass, Woolly	60	30	55	55	40	50	50	—	—	—	—	—	—	—
Foxtail, Giant	98	95	100	95	40	85	98	100	100	100	90	100	98	40
Foxtail, Green	90	90	90	90	90	95	95	—	—	—	—	—	—	—
Galium	95	5	60	60	95	100	80	80	5	98	85	5	100	0
Goosegrass	100	98	100	98	70	98	90	—	—	—	—	—	—	—
Johnsongrass	45	15	90	0	5	40	15	90	40	80	75	100	35	30
Kochia	55	65	55	50	30	35	40	—	—	—	—	—	—	—
Lambsquarters	95	60	80	55	10	35	15	95	100	90	100	100	—	—
Morningglory	15	15	—	15	35	30	20	20	0	10	5	5	55	20
Nightshade	90	—	95	35	—	98	25	—	—	—	—	—	—	—
Nutsedge, Yellow	5	0	0	—	0	0	0	0	0	0	0	0	0	0
Oat, Wild	80	10	85	45	5	60	35	—	—	—	—	—	—	—
Oilseed Rape	—	—	—	—	—	—	—	90	5	50	10	5	80	0
Pigweed	98	98	98	90	85	100	100	100	100	100	100	100	100	95
Ragweed	40	0	40	0	0	25	15	5	0	20	5	0	50	0
Russian Thistle	85	—	—	0	0	0	—	—	—	—	—	—	—	—
Ryegrass, Italian	10	35	30	5	0	10	5	60	10	35	45	15	60	10
Soybean	5	5	0	—	10	—	5	20	0	0	5	5	15	5
Sunflower	5	0	15	0	10	15	0	—	—	—	—	—	—	—
Surinam Grass	55	15	60	35	10	55	60	—	—	—	—	—	—	—
Velvetleaf	5	0	35	0	0	25	15	—	5	30	5	5	55	0

TABLE C-continued

Waterhemp	—	—	—	—	—	—	—	100	95	100	100	100	100	90
Wheat	5	0	0	0	0	0	0	10	0	5	0	0	0	0

	Compounds													
31 g ai/ha	164	166	168	169	170	171	172	174	179	183	185	188	189	195
Preemergence														
Barnyardgrass	5	5	75	40	80	5	85	5	40	40	55	80	45	—
Bermudagrass	—	—	—	—	—	—	—	—	—	—	—	—	—	98
Blackgrass	5	15	90	80	90	5	90	80	80	80	90	80	90	90
Bromegrass, Downy	—	—	—	—	—	—	—	—	—	—	—	—	—	15
Cocklebur	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Corn	0	0	5	5	5	0	5	0	5	15	5	5	5	0
Crabgrass, Large	70	85	100	100	100	85	100	60	100	100	100	98	98	98
Cupgrass, Woolly	—	—	—	—	—	—	—	—	—	—	—	—	—	20
Foxtail, Giant	50	100	100	100	98	98	100	40	100	100	100	100	100	98
Foxtail, Green	—	—	—	—	—	—	—	—	—	—	—	—	—	90
Galium	0	10	85	100	98	5	80	5	80	60	80	90	80	10
Goosegrass	—	—	—	—	—	—	—	—	—	—	—	—	—	98
Johnsongrass	5	10	75	20	50	0	60	5	5	10	25	55	50	—
Kochia	—	—	—	—	—	—	—	—	—	—	—	—	—	60
Lambsquarters	85	—	98	90	85	100	90	85	98	80	100	90	85	55
Morningglory	5	—	45	25	35	0	30	0	5	30	45	—	10	30
Nightshade	—	—	—	—	—	—	—	—	—	—	—	—	—	60
Nutsedge, Yellow	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Oat, Wild	—	—	—	—	—	—	—	—	—	—	—	—	—	80
Oilseed Rape	5	50	100	50	95	0	60	0	80	60	60	20	—	—
Pigweed	10	100	100	100	100	60	100	98	100	100	100	100	98	98
Ragweed	20	20	10	15	5	0	35	5	40	50	40	—	—	15
Russian Thistle	—	—	—	—	—	—	—	—	—	—	—	—	—	90
Ryegrass, Italian	5	5	70	85	55	10	100	10	45	65	90	60	60	50
Soybean	0	5	5	0	5	0	5	0	0	5	5	5	5	0
Sunflower	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Surinam Grass	—	—	—	—	—	—	—	—	—	—	—	—	—	55
Velvetleaf	10	0	80	50	60	5	60	5	30	45	60	45	15	10
Waterhemp	—	55	—	—	—	—	—	—	—	—	—	100	98	—
Wheat	0	0	5	5	10	0	15	0	5	5	10	30	5	0

31 g ai/ha	Compound 196	31 g ai/ha	Compound 196
Preemergence			
Barnyardgrass	—	Morningglory	40
Bermudagrass	98	Nightshade	100
Blackgrass	90	Nutsedge, Yellow	0
Bromegrass, Downy	60	Oat, Wild	80
Cocklebur	5	Oilseed Rape	—
Corn	25	Pigweed	95
Crabgrass, Large	100	Ragweed	40
Cupgrass, Woolly	90	Russian Thistle	90
Foxtail, Giant	100	Ryegrass, Italian	80
Foxtail, Green	90	Soybean	10
Galium	85	Sunflower	5
Goosegrass	100	Surinam Grass	90
Johnsongrass	98	Velvetleaf	60
Kochia	90	Waterhemp	—
Lambsquarters	85	Wheat	0

16 g ai/ha	Compound 15	16 g ai/ha	Compound 15
Preemergence			
Bermudagrass	100	Lambsquarters	95
Blackgrass	15	Morningglory	5
Bromegrass, Downy	15	Nightshade	10
Cocklebur	0	Nutsedge, Yellow	0
Corn	0	Oat, Wild	35
Crabgrass, Large	98	Pigweed	98
Cupgrass, Woolly	5	Russian Thistle	5
Foxtail, Giant	95	Ryegrass, Italian	10
Foxtail, Green	95	Soybean	0
Galium	50	Sunflower	0
Goosegrass	100	Surinam Grass	10

TABLE C-continued

Johnsongrass	15	Velvetleaf	0
Kochia	0	Wheat	0

	Compounds			Compounds	
16 g ai/ha	160	189	16 g ai/ha	160	189
Preemergence					
Barnyardgrass	5	25	Nutsedge, Yellow	0	0
Blackgrass	0	75	Oilseed Rape	0	5
Corn	5	5	Pigweed	90	85
Crabgrass, Large	90	98	Ragweed	0	—
Foxtail, Giant	80	100	Ryegrass, Italian	5	50
Galium	—	80	Soybean	0	5
Johnsongrass	85	30	Velvetleaf	0	10
Lambsquarters	95	45	Waterhemp	100	90
Morningglory	0	—	Wheat	0	0

Test D

Seeds of plant species selected from bluegrass (annual bluegrass, *Poa annua*), blackgrass (*Alopecurus myosuroides*), canarygrass (*Phalaris minor*), chickweed (common chickweed, *Stellaria media*), *galium* (catchweed bedstraw, *Galium aparine*), bromegrass, downy (downy bromegrass, *Bromus tectorum*), field poppy (*Papaver rhoeas*), field violet (*Viola arvensis*), foxtail, green (green foxtail, *Setaria viridis*), deadnettle (henbit deadnettle, *Lamium amplexicaule*), ryegrass, Italian (Italian ryegrass, *Lolium multiflorum*), *kochia* (*Kochia scoparia*), lambsquarters (*Chenopodium album*), oilseed rape (*Brassica napus*), pigweed (*Amaranthus retroflexus*), Russian thistle (*Salsola iberica*), chamomile (scentless chamomile, *Matricaria inodora*), speedwell (bird's-eye speedwell, *Veronica persica*), barley, spring (spring barley, *Hordeum vulgare*), wheat, spring (spring wheat, *Triticum aestivum*), buckwheat, wild (wild buckwheat, *Polygonum convolvulus*), mustard, wild (wild mustard, *Sinapis arvensis*), oat, wild (wild oat, *Avena fatua*), radish, wild (wild radish, *Raphanus raphanistrum*), windgrass (*Apera spica-venti*), barley, winter (winter barley, *Hordeum vulgare*), and wheat, winter (winter wheat, *Triticum aestivum*) were planted into a silt loam soil and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. At the same time, these same crop and weed species were planted in pots containing the planting medium comprising spaghnum peat moss, vermiculite, wetting agent and starter nutrients and treated with postemergence applications of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage).

Treated plants and controls were maintained in a controlled growth environment for 14 to 21 days after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table D, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE D

	Compounds						
250 g ai/ha	14	15	16	23	106	120	129
Postemergence							
Barley, Spring	40	40	35	15	30	30	10
Barley, Winter	40	40	40	20	10	40	30
Blackgrass	85	85	40	30	30	85	70
Bluegrass	95	95	70	40	30	95	70
Bromegrass, Downy	40	40	50	25	15	25	30
Buckwheat, Wild	100	100	50	75	100	98	100
Canarygrass	80	80	80	30	30	95	80
Chamomile	100	100	10	5	25	90	35
Chickweed	98	100	95	90	90	100	100
Deadnettle	100	100	90	90	80	100	100
Field Poppy	100	100	100	100	100	100	85
Field Violet	100	100	80	80	100	100	80
Foxtail, Green	95	100	95	25	40	100	100
Galium	70	100	70	90	60	100	98
Kochia	100	100	95	95	100	100	100
Lambsquarters	100	100	100	100	90	100	100
Mustard, Wild	100	100	100	100	100	—	—
Oat, Wild	55	40	50	20	20	70	25
Oilseed Rape	100	100	100	95	95	98	100
Pigweed	100	100	100	100	90	100	100
Radish, Wild	100	100	100	100	100	100	100
Russian Thistle	100	100	100	100	100	100	100
Ryegrass, Italian	35	20	35	15	20	30	15
Speedwell	100	100	100	60	90	100	100

TABLE D-continued

Wheat, Spring	40	50	20	15	20	25	20
Wheat, Winter	25	35	25	15	5	20	20
Windgrass	100	100	35	30	50	100	95

	Compounds				Compounds		
250 g ai/ha	137	138	195	250 g ai/ha	137	138	195
Postemergence							
Barley, Spring	40	40	40	Kochia	100	100	100
Barley, Winter	10	20	45	Lambsquarters	95	100	100
Blackgrass	80	85	70	Mustard, Wild	100	100	100
Bluegrass	90	85	80	Oat, Wild	50	75	45
Bromegrass, Downy	40	50	40	Oilseed Rape	100	100	100
Buckwheat, Wild	80	80	65	Pigweed	100	100	95
Canarygrass	75	80	55	Radish, Wild	100	100	—
Chamomile	40	80	50	Russian Thistle	90	100	100
Chickweed	90	100	90	Ryegrass, Italian	40	50	25
Deadnettle	85	95	90	Speedwell	100	100	100
Field Poppy	100	100	100	Wheat, Spring	25	35	35
Field Violet	95	90	95	Wheat, Winter	20	25	40
Foxtail, Green	95	100	100	Windgrass	80	90	80
Galium	75	100	80				

	Compounds						
125 g ai/ha	14	15	16	23	106	120	129
Postemergence							
Barley, Spring	30	30	20	10	20	15	10
Barley, Winter	35	20	25	10	5	20	15
Blackgrass	70	50	25	20	20	75	50
Bluegrass	70	50	60	30	15	70	60
Bromegrass, Downy	30	20	40	20	15	20	30
Buckwheat, Wild	60	70	20	40	10	95	100
Canarygrass	55	50	40	25	20	90	70
Chamomile	100	25	5	0	0	80	30
Chickweed	90	100	95	30	90	100	100
Deadnettle	100	100	50	60	60	100	98
Field Poppy	100	100	100	100	100	100	100
Field Violet	100	100	70	70	85	100	100
Foxtail, Green	30	75	90	25	30	95	95
Galium	55	100	60	70	40	98	85
Kochia	100	100	75	90	95	100	100
Lambsquarters	100	100	100	100	50	100	100
Mustard, Wild	100	100	—	100	90	—	—
Oat, Wild	40	30	45	15	5	35	20
Oilseed Rape	90	100	100	85	80	90	100
Pigweed	100	100	90	95	90	100	100
Radish, Wild	100	100	100	75	100	100	100
Russian Thistle	100	100	100	90	60	100	100
Ryegrass, Italian	25	10	30	10	10	15	10
Speedwell	100	100	95	50	90	100	100
Wheat, Spring	35	40	15	10	10	20	15
Wheat, Winter	15	25	20	15	5	15	20
Windgrass	75	75	25	20	35	100	70

	Compounds								
125 g ai/ha	137	138	145	147	148	155	156	195	196
Postemergence									
Barley, Spring	30	35	20	25	25	35	30	30	55
Barley, Winter	1	20	20	30	30	35	30	30	40
Blackgrass	70	80	30	60	65	85	60	50	80
Bluegrass	80	70	40	70	70	90	80	60	80
Bromegrass, Downy	30	40	10	50	20	55	35	35	65
Buckwheat, Wild	65	80	85	70	70	75	85	35	95
Canarygrass	50	50	60	80	70	85	80	40	85
Chamomile	20	60	30	80	95	85	100	20	85
Chickweed	85	95	90	80	90	100	95	85	100
Deadnettle	80	80	100	100	100	100	100	75	100
Field Poppy	100	100	100	100	100	100	100	100	100
Field Violet	90	85	95	90	95	95	95	85	100
Foxtail, Green	80	80	100	60	60	80	65	100	95
Galium	75	90	70	90	75	75	80	75	90
Kochia	95	100	100	95	85	85	90	100	90

TABLE D-continued

Lambsquarters	95	95	100	95	95	95	95	95	95
Mustard, Wild	95	100	100	100	100	100	100	95	100
Oat, Wild	35	50	35	35	55	75	65	35	70
Oilseed Rape	100	100	100	100	100	100	100	100	100
Pigweed	100	100	100	95	95	95	95	80	100
Radish, Wild	100	100	—	100	100	100	100	—	100
Russian Thistle	85	95	100	80	75	85	80	85	75
Ryegrass, Italian	35	40	30	35	20	60	25	20	75
Speedwell	95	98	100	—	—	—	—	100	—
Wheat, Spring	20	25	25	25	25	50	25	25	35
Wheat, Winter	15	20	10	20	25	25	20	25	35
Windgrass	50	60	80	75	80	95	80	70	95

	Compounds						
62 g ai/ha	14	15	16	23	106	120	129
Postemergence							
Barley, Spring	25	25	15	10	15	15	5
Barley, Winter	25	15	10	10	5	20	10
Blackgrass	35	30	20	10	10	30	10
Bluegrass	35	25	40	25	10	40	20
Bromegrass, Downy	20	10	20	15	10	10	20
Buckwheat, Wild	40	30	10	35	10	85	80
Canarygrass	40	40	35	20	10	20	15
Chamomile	60	0	0	0	0	40	30
Chickweed	80	100	90	15	90	98	100
Deadnettle	40	98	45	50	40	90	80
Field Poppy	100	100	100	90	100	100	100
Field Violet	100	100	30	50	70	100	100
Foxtail, Green	25	80	80	20	20	80	85
Galium	55	70	50	50	40	70	75
Kochia	95	90	95	85	70	100	100
Lambsquarters	80	100	100	80	30	100	95
Mustard, Wild	90	100	90	85	80	—	—
Oat, Wild	25	10	30	10	5	20	10
Oilseed Rape	70	70	95	75	10	80	95
Pigweed	100	80	80	80	60	90	100
Radish, Wild	85	100	100	40	100	90	100
Russian Thistle	75	100	100	70	30	98	100
Ryegrass, Italian	20	5	25	10	5	10	5
Speedwell	100	100	85	20	0	100	100
Wheat, Spring	20	30	10	10	5	10	10
Wheat, Winter	5	15	15	10	5	10	10
Windgrass	40	25	20	10	25	95	30

	Compounds								
62 g ai/ha	137	138	145	147	148	155	156	195	196
Postemergence									
Barley, Spring	25	25	15	20	20	25	25	20	35
Barley, Winter	5	15	10	25	25	25	25	15	35
Blackgrass	50	70	25	30	30	60	35	35	85
Bluegrass	40	50	25	55	25	75	70	40	75
Bromegrass, Downy	20	30	10	15	15	35	15	20	50
Buckwheat, Wild	65	50	45	65	75	70	80	30	90
Canarygrass	30	30	35	55	20	70	65	20	80
Chamomile	15	30	10	75	75	80	75	20	75
Chickweed	80	85	80	80	80	75	90	60	95
Deadnettle	70	75	90	90	100	90	100	75	100
Field Poppy	100	90	100	100	95	100	100	95	100
Field Violet	85	75	95	100	95	100	95	75	95
Foxtail, Green	70	75	100	25	50	70	25	75	85
Galium	40	80	40	75	70	70	75	50	70
Kochia	90	100	100	90	85	85	95	95	90
Lambsquarters	80	90	100	90	95	90	85	80	90
Mustard, Wild	80	95	90	100	100	100	100	80	100
Oat, Wild	20	30	30	30	30	55	20	25	45
Oilseed Rape	98	100	70	95	80	100	100	95	100
Pigweed	95	95	100	85	95	95	90	75	95
Radish, Wild	90	95	—	95	100	95	100	—	100
Russian Thistle	85	90	98	80	85	85	90	80	80
Ryegrass, Italian	25	35	15	15	20	25	10	20	30
Speedwell	85	90	85	—	—	—	—	100	—
Wheat, Spring	10	10	20	20	20	25	20	20	35

TABLE D-continued

Wheat, Winter	10	20	10	15	15	15	15	10	25
Windgrass	40	50	60	50	60	80	70	30	95

	Compounds						
31 g ai/ha	14	15	16	23	106	120	129
Postemergence							
Barley, Spring	25	15	15	0	10	10	5
Barley, Winter	10	10	10	0	5	15	5
Blackgrass	25	15	10	10	10	10	10
Bluegrass	20	10	20	20	10	10	10
Bromegrass, Downy	15	10	10	10	0	10	10
Buckwheat, Wild	0	30	0	25	0	75	60
Canarygrass	25	35	30	15	5	5	10
Chamomile	20	0	0	0	0	25	30
Chickweed	50	100	70	10	90	85	90
Deadnettle	25	75	25	30	30	90	75
Field Poppy	100	100	100	70	100	100	100
Field Violet	100	100	20	40	70	70	100
Foxtail, Green	10	30	30	15	10	15	35
Galium	45	55	40	30	40	60	50
Kochia	95	90	90	80	60	98	98
Lambsquarters	80	100	80	30	30	98	85
Mustard, Wild	50	70	—	40	80	—	—
Oat, Wild	15	10	10	10	5	10	10
Oilseed Rape	30	100	70	50	10	50	80
Pigweed	100	80	70	50	50	90	100
Radish, Wild	70	100	100	20	100	100	90
Russian Thistle	0	100	95	50	25	95	98
Ryegrass, Italian	5	5	20	10	5	5	5
Speedwell	100	100	75	10	0	100	100
Wheat, Spring	15	25	10	5	5	10	10
Wheat, Winter	5	10	10	5	5	5	5
Windgrass	30	10	10	5	10	15	20

	Compounds								
31 g ai/ha	137	138	145	147	148	155	156	195	196
Postemergence									
Barley, Spring	15	20	10	15	15	15	20	15	20
Barley, Winter	5	5	5	20	20	20	20	10	20
Blackgrass	30	50	20	25	15	50	15	25	65
Bluegrass	20	30	20	10	15	35	65	20	70
Bromegrass, Downy	15	20	5	5	5	15	10	15	35
Buckwheat, Wild	30	40	35	50	60	70	75	20	70
Canarygrass	20	25	35	35	30	70	30	10	70
Chamomile	10	10	10	60	70	70	70	20	70
Chickweed	50	60	60	70	70	70	75	40	85
Deadnettle	40	50	70	95	65	75	85	65	100
Field Poppy	40	90	100	90	100	95	100	75	100
Field Violet	70	70	75	95	95	100	95	70	85
Foxtail, Green	50	40	60	15	15	15	25	50	80
Galium	20	75	35	65	70	70	75	30	85
Kochia	85	95	98	85	85	80	80	85	85
Lambsquarters	75	80	90	75	85	95	90	75	90
Mustard, Wild	60	90	75	100	100	100	95	80	100
Oat, Wild	10	20	20	15	15	20	15	20	50
Oilseed Rape	90	95	50	60	35	100	100	85	100
Pigweed	90	95	95	70	85	75	90	65	95
Radish, Wild	40	80	—	100	100	95	85	—	100
Russian Thistle	—	75	95	85	75	80	85	40	90
Ryegrass, Italian	10	25	10	10	15	15	15	10	15
Speedwell	70	80	70	—	—	—	—	100	—
Wheat, Spring	5	5	10	15	10	20	15	10	25
Wheat, Winter	5	20	10	15	10	10	15	10	20
Windgrass	20	30	35	25	30	70	50	15	75

	Compounds					
16 g ai/ha	15	16	23	106	120	129
Postemergence						
Barley, Spring	10	5	0	5	5	5
Barley, Winter	10	5	0	0	10	5
Blackgrass	15	5	5	5	5	5

TABLE D-continued

Bluegrass	0	10	20	10	10	10
Bromegrass, Downy	5	0	0	0	5	10
Buckwheat, Wild	0	0	20	0	50	60
Canarygrass	25	20	10	5	0	10
Chamomile	0	0	0	0	10	20
Chickweed	40	40	5	20	75	75
Deadnettle	50	10	20	20	30	60
Field Poppy	100	0	75	100	100	100
Field Violet	80	0	20	70	70	40
Foxtail, Green	15	30	15	0	5	35
Galium	50	20	25	20	50	40
Kochia	20	85	20	60	98	98
Lambsquarters	50	75	30	20	95	85
Mustard, Wild	0	10	20	20	—	—
Oat, Wild	10	0	10	0	10	10
Oilseed Rape	70	40	50	10	20	80
Pigweed	80	50	50	10	0	100
Radish, Wild	100	90	20	100	100	90
Russian Thistle	60	90	50	20	95	98
Ryegrass, Italian	0	10	5	5	5	5
Speedwell	100	25	5	0	60	100
Wheat, Spring	20	5	0	0	10	5
Wheat, Winter	5	5	0	5	5	5
Windgrass	5	0	0	5	5	15

	Compounds								
16 g ai/ha	137	138	145	147	148	155	156	195	196
Postemergence									
Barley, Spring	10	10	10	15	10	10	15	10	15
Barley, Winter	0	5	5	15	10	15	10	0	15
Blackgrass	10	30	20	15	10	5	10	20	15
Bluegrass	5	20	0	5	5	20	15	10	60
Bromegrass, Downy	5	10	5	5	5	5	10	5	15
Buckwheat, Wild	30	40	30	45	60	75	70	15	50
Canarygrass	10	10	30	15	10	20	15	10	30
Chamomile	0	0	0	45	60	60	50	20	60
Chickweed	40	60	75	60	60	65	60	30	70
Deadnettle	20	50	50	65	70	75	70	60	85
Field Poppy	30	80	75	90	90	80	85	35	100
Field Violet	50	60	80	95	90	95	95	70	80
Foxtail, Green	40	20	5	15	15	20	10	30	55
Galium	20	60	30	55	60	65	70	20	70
Kochia	75	95	90	70	75	70	75	70	70
Lambsquarters	40	70	25	75	85	95	85	60	85
Mustard, Wild	50	75	70	95	55	80	100	60	100
Oat, Wild	0	10	10	10	5	10	10	10	15
Oilseed Rape	70	85	50	25	30	85	100	70	80
Pigweed	90	90	70	75	70	70	85	60	85
Radish, Wild	40	80	—	85	90	85	65	—	65
Russian Thistle	30	50	40	45	65	70	60	15	80
Ryegrass, Italian	0	10	0	5	5	5	5	5	5
Speedwell	70	80	55	—	—	—	—	100	—
Wheat, Spring	0	5	5	10	10	15	10	5	15
Wheat, Winter	5	10	5	10	10	5	10	5	15
Windgrass	10	15	10	15	15	20	25	10	60

8 g ai/ha	Compound 145	8 g ai/ha	Compound 145
Postemergence			
Barley, Spring	5	Galium	5
Barley, Winter	0	Kochia	80
Blackgrass	5	Lambsquarters	10
Bluegrass	0	Mustard, Wild	25
Bromegrass, Downy	5	Oat, Wild	10
Buckwheat, Wild	15	Oilseed Rape	0
Canarygrass	20	Pigweed	20
Chamomile	0	Russian Thistle	10
Chickweed	40	Ryegrass, Italian	0
Deadnettle	0	Speedwell	50
Field Poppy	25	Wheat, Spring	5

TABLE D-continued

Field Violet	70	Wheat, Winter	5
Foxtail, Green	5	Windgrass	5

	Compounds						
250 g ai/ha	14	15	16	106	120	129	195
Preemergence							
Barley, Spring	20	15	5	0	20	20	30
Barley, Winter	35	30	25	20	40	15	20
Blackgrass	60	90	100	0	100	100	100
Bluegrass	100	100	100	0	100	100	80
Bromegrass, Downy	30	40	40	0	60	30	50
Buckwheat, Wild	40	100	20	100	100	100	40
Canarygrass	98	100	100	0	100	100	95
Chamomile	—	—	100	—	100	100	100
Chickweed	100	100	—	100	100	100	—
Deadnettle	100	100	100	0	100	100	100
Field Poppy	—	—	100	—	100	100	100
Field Violet	95	—	100	—	100	100	—
Foxtail, Green	100	100	100	100	100	100	100
Galium	100	100	20	80	100	100	80
Kochia	90	100	100	30	100	100	85
Lambsquarters	75	100	100	40	100	100	75
Mustard, Wild	95	100	100	60	100	100	100
Oat, Wild	50	100	100	10	100	100	75
Oilseed Rape	40	75	100	20	70	60	20
Pigweed	100	100	100	40	100	100	95
Radish, Wild	100	100	—	30	100	100	—
Russian Thistle	40	80	90	0	100	100	30
Ryegrass, Italian	50	70	60	0	100	90	60
Speedwell	100	—	100	—	—	—	100
Wheat, Spring	15	5	10	0	20	15	0
Wheat, Winter	20	5	0	0	10	10	10
Windgrass	85	100	100	80	100	100	100

	Compounds					
125 g ai/ha	14	15	16	106	120	129
Preemergence						
Barley, Spring	15	10	5	0	10	15
Barley, Winter	10	20	10	0	15	10
Blackgrass	10	80	70	0	100	100
Bluegrass	85	80	30	0	100	100
Bromegrass, Downy	20	0	25	0	25	20
Buckwheat, Wild	35	100	0	100	70	70
Canarygrass	90	90	90	0	100	100
Chamomile	—	—	70	—	100	30
Chickweed	100	100	—	100	100	100
Deadnettle	100	95	100	0	100	100
Field Poppy	—	—	100	—	100	100
Field Violet	95	—	90	—	100	100
Foxtail, Green	75	100	100	0	100	100
Galium	100	100	20	40	100	100
Kochia	80	70	90	30	95	100
Lambsquarters	60	100	95	40	100	90
Mustard, Wild	90	100	100	50	100	80
Oat, Wild	20	40	100	10	55	55
Oilseed Rape	30	20	50	10	30	30
Pigweed	90	98	90	20	100	100
Radish, Wild	100	100	—	30	90	100
Russian Thistle	10	80	—	0	100	100
Ryegrass, Italian	25	25	60	0	80	70
Speedwell	100	—	100	—	—	—
Wheat, Spring	5	0	5	0	10	5
Wheat, Winter	10	0	0	0	5	5
Windgrass	40	100	100	25	100	75

	Compounds					
125 g ai/ha	147	148	155	156	195	196
Preemergence						
Barley, Spring	10	5	10	15	0	30
Barley, Winter	15	5	10	15	0	40
Blackgrass	40	5	70	70	80	100

TABLE D-continued

Bluegrass	35	50	85	100	50	100
Bromegrass, Downy	15	20	35	95	35	90
Buckwheat, Wild	100	50	70	100	20	95
Canarygrass	100	100	100	100	80	100
Chamomile	95	100	100	100	100	100
Chickweed	100	100	100	100	—	100
Deadnettle	100	100	95	100	100	100
Field Poppy	100	95	100	100	100	100
Field Violet	100	100	100	100	—	100
Foxtail, Green	100	100	100	100	100	100
Galium	—	—	—	—	30	—
Kochia	70	75	75	80	80	100
Lambsquarters	85	90	90	100	30	100
Mustard, Wild	95	95	100	100	100	100
Oat, Wild	70	65	60	90	75	100
Oilseed Rape	15	20	100	100	10	100
Pigweed	100	100	100	100	100	100
Radish, Wild	100	100	100	100	—	100
Russian Thistle	—	—	—	—	0	—
Ryegrass, Italian	30	35	65	60	20	100
Speedwell	100	100	100	100	100	100
Wheat, Spring	5	5	5	5	0	25
Wheat, Winter	5	10	5	5	0	15
Windgrass	100	90	100	100	100	100

	Compounds					
62 g ai/ha	14	15	16	106	120	129
Preemergence						
Barley, Spring	10	0	5	0	5	5
Barley, Winter	0	5	5	0	10	0
Blackgrass	0	25	40	0	98	30
Bluegrass	30	5	20	0	100	85
Bromegrass, Downy	10	0	25	0	5	10
Buckwheat, Wild	30	100	0	100	10	0
Canarygrass	25	80	50	0	100	100
Chamomile	—	—	25	—	20	30
Chickweed	100	100	—	100	90	100
Deadnettle	70	40	60	0	100	100
Field Poppy	—	—	100	—	80	70
Field Violet	90	—	80	—	95	100
Foxtail, Green	10	100	100	0	100	100
Galium	0	30	—	0	65	100
Kochia	40	0	90	0	30	75
Lambsquarters	40	90	80	40	90	90
Mustard, Wild	50	100	100	50	90	40
Oat, Wild	20	15	10	0	25	5
Oilseed Rape	0	10	50	10	10	10
Pigweed	70	70	80	0	100	90
Radish, Wild	40	0	—	30	20	10
Russian Thistle	0	0	40	0	100	100
Ryegrass, Italian	25	5	10	0	40	10
Speedwell	100	—	40	—	—	—
Wheat, Spring	0	0	0	0	5	0
Wheat, Winter	0	0	0	0	5	0
Windgrass	20	40	90	5	100	10

	Compounds					
62 g ai/ha	147	148	155	156	195	196
Preemergence						
Barley, Spring	5	5	5	5	0	15
Barley, Winter	5	5	5	10	0	15
Blackgrass	30	5	20	15	75	100
Bluegrass	20	60	60	40	20	75
Bromegrass, Downy	10	10	10	20	25	70
Buckwheat, Wild	30	65	50	65	20	70
Canarygrass	100	60	100	100	40	100
Chamomile	90	70	95	100	100	100
Chickweed	70	70	100	100	—	100
Deadnettle	100	100	80	100	60	100
Field Poppy	95	100	95	95	60	100
Field Violet	95	95	95	100	—	100
Foxtail, Green	75	70	85	30	100	75
Galium	—	—	—	—	10	—
Kochia	50	10	65	65	60	100

TABLE D-continued

Lambsquarters	80	80	90	85	0	100
Mustard, Wild	100	55	100	95	40	100
Oat, Wild	35	30	15	25	0	75
Oilseed Rape	5	10	100	85	0	100
Pigweed	80	85	100	100	60	100
Radish, Wild	100	100	100	100	—	70
Russian Thistle	—	—	—	—	0	—
Ryegrass, Italian	15	5	10	5	0	60
Speedwell	100	50	100	100	100	100
Wheat, Spring	0	0	0	0	0	5
Wheat, Winter	0	0	5	0	0	10
Windgrass	100	35	85	85	75	100

	Compounds							Compounds		
31 g ai/ha	14	15	16	106	120	129	16 g ai/ha	16	120	129
Preemergence										
Barley, Spring	0	0	0	0	0	0	Barley, Spring	0	0	0
Barley, Winter	0	0	0	0	0	0	Barley, Winter	0	0	0
Blackgrass	0	0	0	0	80	0	Blackgrass	0	0	0
Bluegrass	0	0	20	—	100	0	Bluegrass	0	0	0
Bromegrass, Downy	0	0	20	0	0	10	Bromegrass, Downy	0	0	0
Buckwheat, Wild	0	0	0	50	—	0	Buckwheat, Wild	0	—	0
Canarygrass	10	25	40	0	90	15	Canarygrass	20	0	0
Chamomile	—	—	0	—	10	30	Chamomile	0	0	0
Chickweed	75	100	—	100	90	100	Chickweed	—	20	0
Deadnettle	60	10	40	0	85	10	Deadnettle	0	0	0
Field Poppy	—	—	100	—	80	75	Field Poppy	100	0	0
Field Violet	75	—	30	—	90	100	Field Violet	0	75	100
Foxtail, Green	0	70	100	0	100	90	Foxtail, Green	25	70	5
Galium	—	—	0	0	15	0	Galium	0	0	—
Kochia	10	0	30	0	10	25	Kochia	30	0	20
Lambsquarters	0	0	50	40	80	80	Lambsquarters	30	—	0
Mustard, Wild	0	100	0	20	—	5	Mustard, Wild	0	0	0
Oat, Wild	0	—	10	0	5	0	Oat, Wild	0	0	0
Oilseed Rape	0	0	0	10	10	0	Oilseed Rape	0	0	0
Pigweed	20	20	80	0	100	80	Pigweed	25	30	30
Radish, Wild	—	0	—	0	—	0	Radish, Wild	—	0	0
Russian Thistle	0	0	35	0	100	100	Russian Thistle	0	100	80
Ryegrass, Italian	0	0	0	0	5	5	Ryegrass, Italian	0	0	0
Speedwell	100	—	20	—	—	—	Speedwell	—	0	—
Wheat, Spring	0	0	0	0	0	0	Wheat, Spring	0	0	0
Wheat, Winter	0	0	0	0	0	0	Wheat, Winter	0	0	0
Windgrass	10	30	20	5	80	0	Windgrass	20	0	0

	Compounds					
31 g ai/ha	147	148	155	156	195	196
Preemergence						
Barley, Spring	0	0	5	5	0	5
Barley, Winter	0	0	0	5	0	10
Blackgrass	0	10	10	5	70	20
Bluegrass	15	15	15	5	10	35
Bromegrass, Downy	5	0	5	5	0	15
Buckwheat, Wild	10	30	25	50	0	45
Canarygrass	35	50	70	70	25	100
Chamomile	15	20	80	55	0	85
Chickweed	85	60	50	100	—	65
Deadnettle	10	45	5	15	60	40
Field Poppy	75	70	95	100	40	90
Field Violet	100	100	95	95	—	95
Foxtail, Green	25	50	65	10	90	60
Galium	—	—	—	—	0	—
Kochia	15	20	60	30	50	70
Lambsquarters	50	40	55	30	0	65
Mustard, Wild	60	15	55	85	10	95
Oat, Wild	15	20	50	10	0	30
Oilseed Rape	0	0	5	0	0	15
Pigweed	75	70	80	85	60	100
Radish, Wild	10	20	95	10	—	20
Russian Thistle	—	—	—	—	0	—
Ryegrass, Italian	5	5	0	5	0	10
Speedwell	20	95	100	100	100	100
Wheat, Spring	0	0	0	0	0	5

TABLE D-continued

Wheat, Winter	0	5	0	0	0	5
Windgrass	60	10	10	10	40	100

	Compounds					
16 g ai/ha	147	148	155	156	195	196
Preemergence						
Barley, Spring	0	0	0	5	0	5
Barley, Winter	0	0	5	5	0	5
Blackgrass	0	0	5	0	0	10
Bluegrass	0	0	15	5	0	5
Bromegrass, Downy	0	0	0	0	0	5
Buckwheat, Wild	15	20	10	0	0	60
Canarygrass	5	0	10	15	0	40
Chamomile	25	10	5	10	0	55
Chickweed	35	25	35	50	—	50
Deadnettle	5	10	5	5	60	10
Field Poppy	55	10	80	85	30	95
Field Violet	75	90	90	60	—	80
Foxtail, Green	10	15	20	5	15	60
Galium	—	—	—	—	0	—
Kochia	15	10	30	10	40	35
Lambsquarters	5	35	20	25	0	55
Mustard, Wild	55	20	55	10	0	35
Oat, Wild	5	5	5	5	0	25
Oilseed Rape	0	5	0	0	0	5
Pigweed	35	15	60	50	60	65
Radish, Wild	—	10	100	5	—	50
Russian Thistle	—	—	—	—	0	—
Ryegrass, Italian	0	0	0	0	0	5
Speedwell	10	5	100	10	30	5
Wheat, Spring	0	0	0	0	0	0
Wheat, Winter	0	0	0	0	0	5
Windgrass	0	5	5	0	25	20

Test E

Seeds of plant species selected from corn (*Zea mays*), soybean (*Glycine max*), velvetleaf (*Abutilon theophrasti*), lambsquarters (*Chenopodium album*), poinsettia, wild (wild poinsettia, *Euphorbia heterophylla*), pigweed, palmer (palmer pigweed, *Amaranthus palmeri*), waterhemp (common waterhemp, *Amaranthus rudis*), smartweed (ladysthumb smartweed, *Polygonum persicaria*), surinam grass (*Brachiaria decumbens*), crabgrass, large (large crabgrass, *Digitaria sanguinalis*), crabgrass, Brazil (Brazilian crabgrass, *Digitaria horizontalis*), *panicum*, fall (fall *panicum, Panicum dichotomiflorum*), foxtail, giant (giant foxtail, *Setaria* faberii), foxtail, green (green foxtail, *Setaria viridis*), goosegrass (*Eleusine indica*), johnsongrass (*Sorghum halepense*), ragweed (common ragweed, *Ambrosia* elation), barnyardgrass (*Echinochloa crus-galli*), sandbur (southern sandbur, *Cenchrus echinatus*), arrowleaf *sida* (*Sida rhombifolia*), ryegrass, Italian (Italian ryegrass, *Lolium multiflorum*), dayflower, (VA) (Virginia dayflower, *Commelina virginica*), field bindweed (*Convolvulus arvensis*), cocklebur (common cocklebur, *Xanthium strumarium*), morningglory (*Ipomoea coccinea*), nightshade (eastern black nightshade, *Solanum* ptycanthum), *kochia* (*Kochia scoparia*), nutsedge, yellow (yellow nutsedge, *Cyperus esculentus*) and beggarticks (hairy beggarticks, *Bidens pilosa*) were planted into a silt loam soil and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. At the same time, plants selected from these crop and weed species were planted in pots containing a growing medium comprising spaghnum peat moss, vermiculite, wetting agent and starter nutrients and treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm for postemergence treatments (1- to 4-leaf stage).

Treated plants and controls were maintained in a greenhouse for 14 to 21 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table E, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE E

	Compound		Compounds	
250 g ai/ha	47	125 g ai/ha	47	120
Postemergence				
Arrowleaf *Sida*	85	Arrowleaf *Sida*	80	50
Barnyardgrass	60	Barnyardgrass	45	30
Beggarticks	50	Beggarticks	50	35
Corn	20	Corn	20	20
Crabgrass, Brazil	50	Crabgrass, Brazil	40	40
Dayflower, VA	30	Dayflower, VA	25	15

TABLE E-continued

Field Bindweed	65	Field Bindweed	—	35
Panicum, Fall	40	*Panicum*, Fall	30	25
Pigweed, Palmer	100	Pigweed, Palmer	100	100
Poinsettia, Wild	100	*Poinsettia*, Wild	98	90
Ryegrass, Italian	80	Ryegrass, Italian	50	35
Sandbur	50	Sandbur	30	35
Smartweed	85	Smartweed	80	40
Soybean	75	Soybean	60	50
Waterhemp	95	Waterhemp	85	75

	Compounds			Compounds	
62 g ai/ha	47	120	31 g ai/ha	47	120
Postemergence					
Arrowleaf *Sida*	70	50	Arrowleaf *Sida*	60	40
Barnyardgrass	40	25	Barnyardgrass	30	20
Beggarticks	40	30	Beggarticks	30	20
Corn	20	20	Corn	15	10
Crabgrass, Brazil	40	30	Crabgrass, Brazil	30	25
Dayflower, VA	20	10	Dayflower, VA	10	10
Field Bindweed	—	35	Field Bindweed	40	30
Panicum, Fall	30	20	*Panicum*, Fall	20	10
Pigweed, Palmer	95	95	Pigweed, Palmer	90	90
Poinsettia, Wild	90	60	*Poinsettia*, Wild	75	13
Ryegrass, Italian	30	20	Ryegrass, Italian	20	15
Sandbur	25	30	Sandbur	25	20
Smartweed	50	—	Smartweed	40	—
Soybean	60	40	Soybean	50	30
Waterhemp	80	75	Waterhemp	70	65

	Compounds			Compound
16 g ai/ha	47	120	8 g ai/ha	120
Postemergence				
Arrowleaf *Sida*	50	40	Arrowleaf *Sida*	30
Barnyardgrass	30	10	Barnyardgrass	10
Beggarticks	30	10	Beggarticks	10
Corn	10	10	Corn	10
Crabgrass, Brazil	20	15	Crabgrass, Brazil	10
Dayflower, VA	10	10	Dayflower, VA	10
Field Bindweed	—	20	*Panicum*, Fall	5
Panicum, Fall	10	10	Pigweed, Palmer	90
Pigweed, Palmer	70	90	*Poinsettia*, Wild	25
Poinsettia, Wild	75	35	Ryegrass, Italian	0
Ryegrass, Italian	10	10	Sandbur	10
Sandbur	20	10	Smartweed	10
Smartweed	30	10	Soybean	15
Soybean	50	20	Waterhemp	30
Waterhemp	60	50		

	Compounds						Compounds				
250 g ai/ha	14	15	23	47	120	250 g ai/ha	14	15	23	47	120
Preemergence											
Arrowleaf *Sida*	80	60	35	95	50	Morningglory	75	65	—	65	60
Barnyardgrass	60	100	20	100	100	Nightshade	98	100	98	98	100
Beggarticks	100	100	—	—	—	Nutsedge, Yellow	15	0	15	35	25
Cocklebur	—	20	0	50	—	*Panicum*, Fall	100	100	100	100	100
Corn	0	10	20	25	10	Pigweed, Palmer	100	100	100	100	100
Crabgrass, Brazil	100	100	85	100	100	*Poinsettia*, Wild	75	80	35	100	50
Crabgrass, Large	100	100	100	100	100	Ragweed	90	60	25	90	80
Dayflower, VA	75	95	5	—	50	Ryegrass, Italian	100	100	10	100	98
Field Bindweed	75	95	70	100	98	Sandbur	50	100	65	100	75
Foxtail, Giant	100	100	100	100	100	Smartweed	80	100	—	—	—
Foxtail, Green	100	100	95	100	100	Soybean	35	35	20	40	35
Goosegrass	100	100	60	100	100	Surinam Grass	100	100	20	65	100

TABLE E-continued

Johnsongrass	95	100	60	100	65	Velvetleaf	95	95	65	100	65
Kochia	100	100	100	100	100	Waterhemp	100	100	100	100	100
Lambsquarters	98	100	98	100	98						

	Compounds						
125 g ai/ha	14	15	16	23	47	120	129
Preemergence							
Arrowleaf *Sida*	65	50	35	0	60	15	30
Barnyardgrass	60	98	98	20	100	25	35
Beggarticks	98	80	—	—	—	80	—
Cocklebur	50	—	0	0	35	90	35
Corn	0	5	20	0	20	10	10
Crabgrass, Brazil	100	100	100	65	100	100	100
Crabgrass, Large	100	100	90	70	100	100	100
Dayflower, VA	70	60	85	5	—	50	—
Field Bindweed	65	60	50	0	85	40	35
Foxtail, Giant	100	100	100	100	100	100	100
Foxtail, Green	70	100	100	70	100	100	100
Goosegrass	100	100	100	35	100	100	100
Johnsongrass	90	98	98	20	40	35	25
Kochia	98	100	100	100	100	90	95
Lambsquarters	98	100	98	98	100	98	98
Morningglory	75	65	—	—	40	60	50
Nightshade	98	98	100	95	98	98	60
Nutsedge, Yellow	0	0	20	15	10	15	20
Panicum, Fall	100	100	100	100	100	100	100
Pigweed, Palmer	100	100	100	100	100	100	100
Poinsettia, Wild	65	75	98	35	65	35	25
Ragweed	80	30	30	0	50	35	20
Ryegrass, Italian	95	100	98	0	100	90	60
Sandbur	50	90	60	25	—	20	50
Smartweed	—	98	—	—	—	—	—
Soybean	—	35	20	0	40	35	25
Surinam Grass	65	98	35	20	40	90	60
Velvetleaf	80	65	80	65	75	50	25
Waterhemp	100	100	100	98	100	100	100

	Compounds						
62 g ai/ha	14	15	16	23	47	120	129
Preemergence							
Arrowleaf *Sida*	30	40	0	0	40	0	30
Barnyardgrass	35	85	98	0	85	5	10
Beggarticks	90	50	—	—	—	—	—
Cocklebur	0	0	0	0	20	90	35
Corn	0	0	20	0	20	5	10
Crabgrass, Brazil	100	100	100	65	100	100	95
Crabgrass, Large	95	100	90	35	100	98	100
Dayflower, VA	60	25	50	0	—	50	—
Field Bindweed	65	40	20	0	50	20	35
Foxtail, Giant	98	100	—	5	100	100	98
Foxtail, Green	50	90	100	5	100	100	100
Goosegrass	100	100	100	20	—	100	60
Johnsongrass	70	65	40	0	35	15	20
Kochia	90	90	100	60	100	50	95
Lambsquarters	98	100	98	0	98	90	75
Morningglory	35	50	—	—	35	35	40
Nightshade	98	98	100	0	98	80	50
Nutsedge, Yellow	0	0	20	0	10	0	0
Panicum, Fall	100	100	100	80	100	100	100
Pigweed, Palmer	100	100	98	100	100	100	100
Poinsettia, Wild	50	65	40	0	40	0	0
Ragweed	35	—	30	0	10	30	20
Ryegrass, Italian	85	80	50	0	70	35	40
Sandbur	15	50	50	0	90	5	20
Smartweed	80	98	—	—	—	—	—
Soybean	25	20	0	0	40	35	20
Surinam Grass	25	75	30	10	25	35	15

TABLE E-continued

Velvetleaf	50	65	80	10	40	35	20
Waterhemp	100	100	100	80	100	100	100

	Compounds						
31 g ai/ha	14	15	16	23	47	120	129
Preemergence							
Arrowleaf *Sida*	30	30	0	0	20	0	0
Barnyardgrass	15	50	50	0	30	0	5
Beggarticks	50	5	—	—	—	0	—
Cocklebur	0	0	0	0	10	0	0
Corn	0	0	0	0	15	—	0
Crabgrass, Brazil	75	98	95	0	80	100	60
Crabgrass, Large	75	90	5	5	75	95	80
Dayflower, VA	50	10	35	0	—	0	—
Field Bindweed	20	5	0	0	25	10	0
Foxtail, Giant	75	98	100	5	100	100	75
Foxtail, Green	35	—	90	0	100	85	100
Goosegrass	100	100	98	—	100	100	50
Johnsongrass	20	65	20	0	30	15	20
Kochia	50	65	70	0	35	20	50
Lambsquarters	98	100	75	0	95	50	0
Morningglory	20	50	—	—	30	30	0
Nightshade	60	35	50	0	75	0	0
Nutsedge, Yellow	0	0	0	0	0	0	0
Panicum, Fall	80	98	100	15	100	95	98
Pigweed, Palmer	100	100	98	90	100	100	100
Poinsettia, Wild	25	30	20	0	25	0	0
Ragweed	20	5	0	0	0	0	5
Ryegrass, Italian	40	75	30	0	40	35	25
Sandbur	5	25	10	0	20	5	20
Smartweed	25	60	—	—	—	—	—
Soybean	10	0	0	0	40	25	15
Surinam Grass	10	50	0	0	20	35	15
Velvetleaf	35	30	30	0	40	30	0
Waterhemp	98	100	100	80	100	98	80

	Compounds								Compounds	
16 g ai/ha	14	15	16	23	47	120	129	8 g ai/ha	16	129
Preemergence										
Arrowleaf *Sida*	10	—	0	0	0	0	0	Arrowleaf *Sida*	0	0
Barnyardgrass	5	10	10	0	5	0	0	Barnyardgrass	0	0
Beggarticks	5	5	—	—	—	0	—	Cocklebur	—	0
Cocklebur	0	—	0	0	0	0	0	Corn	0	0
Corn	0	0	0	0	0	0	0	Crabgrass, Brazil	30	10
Crabgrass, Brazil	60	60	70	0	35	90	15	Crabgrass, Large	0	0
Crabgrass, Large	65	15	5	5	20	75	10	Dayflower, VA	0	—
Dayflower, VA	10	5	0	0	—	0	—	Field Bindweed	0	0
Field Bindweed	5	5	0	0	25	0	0	Foxtail, Giant	5	0
Foxtail, Giant	50	65	80	0	90	85	20	Foxtail, Green	60	0
Foxtail, Green	25	20	90	0	85	15	60	Goosegrass	40	40
Goosegrass	65	75	40	0	100	95	40	Johnsongrass	0	0
Johnsongrass	10	10	15	0	25	15	20	Kochia	0	35
Kochia	20	35	20	0	25	0	35	Lambsquarters	0	0
Lambsquarters	80	90	0	—	95	0	0	Morningglory	—	0
Morningglory	0	10	—	—	15	0	0	Nightshade	0	0
Nightshade	35	5	0	0	—	0	0	Nutsedge, Yellow	0	0
Nutsedge, Yellow	0	0	0	0	0	0	0	*Panicum*, Fall	0	0
Panicum, Fall	65	98	70	0	100	95	35	Pigweed, Palmer	95	30
Pigweed, Palmer	75	100	98	90	100	65	80	*Poinsettia*, Wild	0	0
Poinsettia, Wild	15	30	0	0	0	0	0	Ragweed	0	0
Ragweed	0	0	0	0	0	0	0	Ryegrass, Italian	0	0
Ryegrass, Italian	0	20	0	0	20	0	25	Sandbur	0	0
Sandbur	5	5	0	0	0	5	0	Soybean	0	0
Soybean	0	0	0	0	0	0	15	Surinam Grass	0	0
Surinam Grass	5	5	0	0	15	0	0	Velvetleaf	0	0
Velvetleaf	20	20	20	0	30	15	0	Waterhemp	60	20
Waterhemp	90	98	70	0	100	95	35			

Test F

Seeds of plant species selected from corn (*Zea mays*), soybean (*Glycine max*), velvetleaf (*Abutilon theophrasti*), lambsquarters (*Chenopodium album*), poinsettia, wild (wild poinsettia, *Euphorbia heterophylla*), pigweed, palmer (palmer pigweed, *Amaranthus palmeri*), waterhemp (common waterhemp, *Amaranthus rudis*), surinam grass (*Brachiaria decumbens*), crabgrass, Brazil (Brazilian crabgrass, *Digitaria horizontalis*), *panicum*, fall (fall *panicum Panicum dichotomiflorum*), crabgrass, large (large crabgrass, *Digitaria sanguinalis*), foxtail, giant (giant foxtail, *Setaria faberii*), foxtail, green (green foxtail *Setaria viridis*), goosegrass (*Eleusine indica*), ragweed (common ragweed, *Ambrosia elatior*), barnyardgrass (*Echinochloa crus-galli*), sandbur (southern sandbur, *Cenchrus echinatus*), arrowleaf *sida* (*Sida rhombifolia*), ryegrass, Italian (Italian ryegrass, *Lolium multiflorum*), dayflower, VA (Virginia (VA) dayflower, *Commelina virginica*), field bindweed (*Convolvulus arvensis*), cocklebur (common cocklebur, *Xanthium strumarium*), morningglory (*Ipomoea coccinea*), nightshade (eastern black nightshade, *Solanum ptycanthum*), *kochia* (*Kochia scoparia*), nutsedge, yellow (yellow nutsedge, *Cyperus esculentus*), johnsongrass (*Sorghum halepense*), smartweed (ladysthumb smartweed, *Polygonum persicaria*), and beggarticks (hairy beggarticks, *Bidens pilosa*), were planted into a silt loam soil and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. At the same time, plants selected from these crop and weed species and also pigweed (*Amaranthus retroflexus*), waterhemp_RES1 (ALS/Triazine resistant common waterhemp, *Amaranthus rudis*) and waterhemp_RES2 (ALS/HPPD resistant common waterhemp, *Amaranthus rudis*) were planted in pots containing a planting medium comprising spaghnum peat moss, vermiculite, wetting agent and starter nutrients treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm for postemergence treatments (1- to 4-leaf stage).

Treated plants and controls were maintained in a greenhouse for 14 to 21 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table E, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE F

	Compounds	
250 g ai/ha	169	172
Postemergence		
Arrowleaf *Sida*	50	100
Barnyardgrass	40	85
Beggarticks	40	60
Corn	10	30
Crabgrass, Brazil	30	90
Dayflower, VA	20	50
Field Bindweed	55	60
Panicum, Fall	30	50
Pigweed, Palmer	100	100
Poinsettia, Wild	85	100
Ryegrass, Italian	30	50
Sandbur	25	40
Smartweed	35	70
Soybean	50	90
Waterhemp	100	100
Waterhemp, Res2	100	—
Waterhemp, Res1	95	95

	Compounds				
125 g ai/ha	141	145	169	172	196
Postemergence					
Arrowleaf *Sida*	75	70	30	90	95
Barnyardgrass	40	40	25	50	90
Beggarticks	75	45	30	50	70
Corn	30	10	10	20	25
Crabgrass, Brazil	95	50	20	70	95
Dayflower, VA	75	70	10	30	70
Field Bindweed	85	75	35	60	75
Panicum, Fall	75	40	25	50	85
Pigweed	95	—	—	—	95
Pigweed, Palmer	100	90	100	100	100
Poinsettia, Wild	98	—	70	100	95
Ryegrass, Italian	40	40	20	40	80
Sandbur	35	35	20	30	50
Smartweed	—	—	25	60	—
Soybean	85	60	40	75	80
Waterhemp	—	95	100	100	—
Waterhemp, Res2	100	85	100	—	95
Waterhemp, Res1	95	90	95	95	100

	Compounds				
62 g ai/ha	141	145	162	169	196
Postemergence					
Arrowleaf *Sida*	70	60	60	20	95
Barnyardgrass	30	30	35	15	60
Beggarticks	60	35	30	25	60
Corn	20	10	10	10	20
Crabgrass, Brazil	95	40	30	20	95
Dayflower, VA	60	60	25	10	60
Field Bindweed	80	70	50	30	75
Panicum, Fall	60	40	30	20	85
Pigweed	95	—	—	—	95
Pigweed, Palmer	100	85	90	90	100
Poinsettia, Wild	95	—	80	60	95
Ryegrass, Italian	25	30	0	20	70
Sandbur	30	35	20	20	30
Smartweed	—	—	15	15	—
Soybean	—	50	55	30	70
Waterhemp	—	95	95	90	—
Waterhemp, Res2	95	—	100	95	95
Waterhemp, Res1	95	—	95	90	95

	Compounds					
31 g ai/ha	141	145	162	169	172	196
Postemergence						
Arrowleaf *Sida*	60	50	35	20	65	90
Barnyardgrass	20	30	25	0	20	60
Beggarticks	50	30	25	25	40	60
Corn	20	10	10	5	15	20

TABLE F-continued

Crabgrass, Brazil	95	40	20	20	50	85
Dayflower, VA	35	50	20	10	20	60
Field Bindweed	70	—	30	20	25	70
Panicum, Fall	50	40	25	15	20	80
Pigweed	95	—	—	—	—	95
Pigweed, Palmer	95	—	90	50	100	100
Poinsettia, Wild	85	—	75	60	80	95
Ryegrass, Italian	15	20	0	0	20	40
Sandbur	20	30	20	15	20	20
Smartweed	—	—	15	10	30	—
Soybean	80	40	45	20	50	65
Waterhemp	—	95	95	90	95	—
Waterhemp, Res2	95	—	95	85	—	95
Waterhemp, Res1	95	—	95	90	70	95

	Compounds						Compounds				
16 g ai/ha	141	145	162	169	196	16 g ai/ha	141	145	162	169	196
Postemergence											
Arrowleaf *Sida*	50	40	30	20	90	Pigweed, Palmer	95	70	80	50	100
Barnyardgrass	20	20	10	0	40	*Poinsettia*, Wild	80	—	60	50	85
Beggarticks	40	25	25	25	60	Ryegrass, Italian	10	10	0	0	20
Corn	15	10	10	5	15	Sandbur	10	20	15	15	20
Crabgrass, Brazil	80	25	15	20	75	Smartweed	—	—	10	10	—
Dayflower, VA	10	20	20	10	50	Soybean	70	35	30	20	60
Field Bindweed	60	60	20	20	60	Waterhemp	—	90	90	75	—
Panicum, Fall	50	25	20	10	40	Waterhemp, Res2	95	—	90	75	90
Pigweed	95	—	—	—	95	Waterhemp, Res1	95	—	90	85	95

	Compounds					Compound
8 g ai/ha	141	145	162	196	4 g ai/ha	162
Postemergence						
Arrowleaf *Sida*	40	30	25	80	Arrowleaf *Sida*	10
Barnyardgrass	10	20	10	30	Barnyardgrass	10
Beggarticks	40	10	20	50	Beggarticks	15
Corn	15	5	5	15	Corn	5
Crabgrass, Brazil	70	15	15	60	Crabgrass, Brazil	15
Dayflower, VA	10	15	15	30	Dayflower, VA	5
Field Bindweed	50	50	20	50	Field Bindweed	20
Panicum, Fall	30	10	20	20	*Panicum*, Fall	15
Pigweed	90	—	—	85	Pigweed, Palmer	70
Pigweed, Palmer	95	40	70	95	*Poinsettia*, Wild	15
Poinsettia, Wild	60	—	30	75	Ryegrass, Italian	0
Ryegrass, Italian	10	5	0	15	Sandbur	10
Sandbur	10	10	10	10	Smartweed	10
Smartweed	—	—	10	—	Soybean	20
Soybean	50	25	30	50	Waterhemp	80
Waterhemp	—	90	90	—	Waterhemp, Res2	75
Waterhemp, Res2	85	—	90	90	Waterhemp, Res1	70
Waterhemp, Res1	90	—	90	95		

	Compounds									
250 g ai/ha	139	146	148	153	154	155	169	171	172	174
Preemergence										
Arrowleaf *Sida*	0	10	0	65	0	75	5	60	100	25
Barnyardgrass	98	20	98	100	100	100	95	100	100	100
Beggarticks	0	0	0	—	15	80	5	0	25	0
Cocklebur	—	—	—	—	0	40	—	—	5	0
Corn	5	0	5	10	5	15	0	5	15	0
Crabgrass, Brazil	—	—	100	100	100	100	100	100	100	100
Crabgrass, Large	100	100	100	100	100	100	100	100	100	100
Dayflower, VA	65	35	90	95	90	60	75	30	90	5
Field Bindweed	20	25	50	100	95	100	80	5	95	5
Foxtail, Giant	100	100	100	100	100	100	100	100	100	100
Foxtail, Green	100	100	100	100	100	100	100	100	100	100
Goosegrass	100	98	100	100	100	100	100	100	100	100
Johnsongrass	100	100	40	100	98	100	80	75	100	70
Kochia	98	98	98	100	98	100	98	98	100	98
Lambsquarters	98	98	100	98	98	98	100	98	98	98
Morningglory	20	25	70	65	—	—	40	65	5	20
Nightshade	100	100	98	100	100	100	100	5	100	35
Nutsedge, Yellow	0	0	35	10	0	30	25	0	25	35

TABLE F-continued

Panicum, Fall	100	100	100	100	100	100	100	100	100	100
Pigweed, Palmer	—	100	100	100	100	100	100	100	100	100
Poinsettia, Wild	80	40	100	98	85	100	98	10	98	30
Ragweed	0	25	75	80	40	80	100	—	—	—
Ryegrass, Italian	95	25	100	95	100	95	100	50	100	80
Sandbur	40	70	100	100	100	100	75	50	100	70
Smartweed	—	—	90	—	—	—	95	5	98	50
Soybean	35	0	40	25	25	30	20	20	20	0
Surinam Grass	75	35	98	98	90	90	100	30	98	50
Velvetleaf	65	25	65	100	100	98	100	50	100	35
Waterhemp	100	100	100	100	100	100	100	100	100	100

	Compounds											
125 g ai/ha	139	142	146	148	153	154	155	169	171	172	174	196
Preemergence												
Arrowleaf *Sida*	0	35	0	0	25	0	40	5	30	95	25	15
Barnyardgrass	10	80	10	20	75	90	30	60	80	100	35	100
Beggarticks	0	75	0	0	65	0	70	5	0	25	0	65
Cocklebur	0	—	—	0	—	—	40	—	—	—	—	0
Corn	0	0	0	0	0	5	15	0	0	15	0	30
Crabgrass, Brazil	—	—	—	100	100	100	100	100	100	100	100	—
Crabgrass, Large	100	100	98	100	100	100	100	100	100	100	95	100
Dayflower, VA	60	70	35	65	80	70	35	65	30	70	5	65
Field Bindweed	0	98	0	20	100	35	95	20	5	95	5	65
Foxtail, Giant	98	100	98	100	100	100	100	100	100	100	90	100
Foxtail, Green	100	100	100	100	100	100	100	100	100	100	95	100
Goosegrass	98	100	75	100	100	100	100	100	100	100	—	100
Johnsongrass	98	30	70	30	100	50	90	50	65	75	30	98
Kochia	90	95	50	95	100	95	98	98	15	100	10	100
Lambsquarters	90	98	98	100	98	98	98	98	65	98	65	98
Morningglory	5	35	0	50	65	—	—	40	35	5	0	70
Nightshade	100	98	65	98	100	90	100	100	5	100	—	100
Nutsedge, Yellow	0	0	0	20	10	0	25	25	0	25	20	75
Panicum, Fall	100	100	100	100	100	100	100	100	100	100	100	100
Pigweed, Palmer	—	—	100	100	100	100	100	100	100	100	98	—
Poinsettia, Wild	75	70	40	20	70	25	80	40	10	50	20	75
Ragweed	0	40	0	75	20	0	50	60	—	—	—	50
Ryegrass, Italian	30	100	20	95	65	70	85	100	25	100	50	100
Sandbur	35	70	25	70	95	98	100	65	50	70	5	98
Smartweed	—	—	—	75	—	—	—	40	0	50	0	—
Soybean	0	25	0	20	5	25	30	—	0	20	0	35
Surinam Grass	75	60	20	98	75	70	90	75	10	35	5	100
Velvetleaf	0	75	0	25	98	40	98	60	15	80	15	95
Waterhemp	100	100	100	100	100	100	100	100	100	100	98	100

	Compounds											
62 g ai/ha	139	142	146	148	153	154	155	162	169	171	174	196
Preemergence												
Arrowleaf *Sida*	0	30	0	0	25	0	10	0	0	15	0	15
Barnyardgrass	10	30	10	0	10	85	30	30	20	5	5	70
Beggarticks	0	65	0	0	35	0	40	0	0	0	0	50
Cocklebur	0	0	—	—	0	0	0	0	0	0	—	0
Corn	0	0	0	0	0	0	10	0	0	0	0	5
Crabgrass, Brazil	—	—	—	100	100	100	100	100	100	100	100	—
Crabgrass, Large	95	98	98	100	100	100	100	100	100	98	95	100
Dayflower, VA	30	50	10	40	40	25	20	65	10	0	0	50
Field Bindweed	0	75	0	0	65	5	85	5	—	0	0	—
Foxtail, Giant	85	100	90	100	100	100	98	100	100	100	70	98
Foxtail, Green	98	98	50	100	100	100	100	100	100	95	75	100
Goosegrass	80	100	70	100	98	95	100	100	100	100	98	100
Johnsongrass	90	—	60	20	50	25	90	20	20	10	30	95
Kochia	35	85	30	90	95	85	70	98	95	5	0	100
Lambsquarters	65	98	40	98	98	75	98	98	98	35	0	95
Morningglory	0	25	0	30	30	—	—	30	30	5	0	70
Nightshade	75	98	65	0	100	10	98	95	100	5	0	100
Nutsedge, Yellow	0	0	0	0	0	0	10	35	—	0	0	10
Panicum, Fall	100	100	90	100	100	100	100	100	100	100	85	100
Pigweed, Palmer	—	—	100	100	100	100	100	100	100	95	75	—
Poinsettia, Wild	35	35	20	0	40	25	40	10	30	0	0	65
Ragweed	0	30	0	0	5	0	5	95	5	—	—	50
Ryegrass, Italian	30	70	15	65	20	10	75	95	5	0	0	75
Sandbur	5	50	10	15	40	80	95	50	20	10	5	90
Smartweed	—	—	—	0	—	—	—	95	40	0	0	—
Soybean	0	0	0	20	0	20	30	25	20	0	0	20

TABLE F-continued

Surinam Grass	5	5	0	75	10	50	70	30	70	5	5	25
Velvetleaf	0	65	0	0	65	30	60	35	0	0	0	75
Waterhemp	100	100	98	100	100	98	100	100	98	—	98	100

	Compounds											
31 g ai/ha	139	142	146	148	153	154	162	169	171	172	174	196
Preemergence												
Arrowleaf *Sida*	0	30	0	0	5	0	0	0	0	30	0	15
Barnyardgrass	10	5	0	0	10	5	30	0	5	70	0	40
Beggarticks	0	40	0	0	25	0	0	0	0	15	0	50
Cocklebur	—	0	—	0	—	—	0	0	0	—	—	0
Corn	0	0	0	0	0	0	0	0	0	0	0	0
Crabgrass, Brazil	—	—	—	100	100	100	100	100	98	100	80	—
Crabgrass, Large	95	20	75	100	95	98	95	98	98	100	85	100
Dayflower, VA	5	5	0	40	10	0	35	5	0	40	0	35
Field Bindweed	0	50	0	0	65	0	5	0	0	5	0	25
Foxtail, Giant	40	75	20	95	85	65	100	100	60	100	5	98
Foxtail, Green	35	75	20	100	75	75	100	100	50	75	50	85
Goosegrass	70	70	40	98	95	95	100	95	80	98	50	75
Johnsongrass	75	5	50	20	10	20	20	0	0	50	0	65
Kochia	0	80	5	90	75	25	70	95	0	20	0	10
Lambsquarters	20	65	0	50	65	30	98	30	0	50	0	80
Morningglory	0	0	0	30	30	—	30	0	0	0	0	30
Nightshade	35	80	10	0	50	10	—	80	0	5	0	95
Nutsedge, Yellow	0	0	0	0	0	0	35	20	0	25	0	0
Panicum, Fall	25	65	5	85	100	90	100	100	65	75	65	98
Pigweed, Palmer	—	—	100	90	100	100	100	100	0	100	0	—
Poinsettia, Wild	20	10	20	0	25	0	10	0	0	20	0	50
Ragweed	0	0	0	0	5	0	70	0	—	—	—	0
Ryegrass, Italian	5	65	10	0	5	0	80	0	0	35	0	75
Sandbur	5	5	0	0	35	30	15	20	5	5	5	5
Smartweed	—	—	—	0	—	—	0	0	0	5	0	—
Soybean	0	0	0	0	0	0	25	0	0	0	0	20
Surinam Grass	0	5	0	40	5	10	—	65	0	20	0	15
Velvetleaf	0	0	0	0	50	20	0	0	0	0	0	20
Waterhemp	100	98	75	90	100	60	100	80	95	98	65	98

	Compounds										
16 g ai/ha	139	142	146	148	153	154	162	169	171	174	196
Preemergence											
Arrowleaf *Sida*	0	0	0	0	5	0	0	0	0	0	0
Barnyardgrass	0	0	0	0	5	0	20	0	0	0	25
Beggarticks	0	0	0	0	0	0	0	0	0	0	50
Cocklebur	—	0	—	—	0	0	—	0	0	—	—
Corn	0	0	0	0	0	0	0	0	0	0	0
Crabgrass, Brazil	—	—	—	100	98	75	100	100	0	0	—
Crabgrass, Large	30	—	0	95	80	50	0	98	75	50	75
Dayflower, VA	0	0	0	0	5	0	35	0	0	0	35
Field Bindweed	0	20	0	0	5	0	5	0	0	0	0
Foxtail, Giant	0	35	20	25	40	5	70	70	40	0	85
Foxtail, Green	10	20	20	35	50	40	80	98	20	35	75
Goosegrass	5	40	0	25	80	10	95	50	70	35	60
Johnsongrass	0	0	0	0	0	0	20	0	0	0	65
Kochia	0	20	0	0	25	5	—	0	0	0	5
Lambsquarters	0	0	0	0	0	0	98	0	0	0	70
Morningglory	0	0	0	0	0	—	20	0	0	0	30
Nightshade	20	65	0	0	50	0	5	0	0	0	95
Nutsedge, Yellow	0	0	0	0	0	0	35	0	0	0	0
Panicum, Fall	0	25	0	75	5	15	100	65	0	0	—
Pigweed, Palmer	—	—	85	0	98	100	98	35	0	0	—
Poinsettia, Wild	0	0	20	0	0	0	0	0	0	0	50
Ragweed	0	0	0	0	5	0	0	0	—	—	0
Ryegrass, Italian	0	5	0	0	5	0	35	0	0	0	40
Sandbur	0	5	0	0	5	0	5	0	0	0	5
Smartweed	—	—	—	0	—	—	0	0	0	0	—
Soybean	0	0	0	0	0	0	0	0	0	0	0
Surinam Grass	0	5	0	25	0	0	—	0	0	0	—

TABLE F-continued

Velvetleaf	0	0	0	0	20	0	0	0	0	0	10
Waterhemp	70	98	25	30	65	50	90	60	0	0	95

	Compounds			Compound
8 g ai/ha	162	196	4 g ai/ha	162
Preemergence				
Arrowleaf *Sida*	0	0	Arrowleaf *Sida*	0
Barnyardgrass	20	0	Barnyardgrass	0
Beggarticks	0	0	Beggarticks	0
Cocklebur	0	—	Cocklebur	0
Corn	0	0	Corn	0
Crabgrass, Brazil	100	—	Crabgrass, Brazil	0
Crabgrass, Large	0	—	Dayflower, VA	0
Dayflower, VA	35	5	Field Bindweed	0
Field Bindweed	0	0	Foxtail, Giant	0
Foxtail, Giant	20	5	Foxtail, Green	0
Foxtail, Green	15	75	Goosegrass	0
Goosegrass	0	40	Johnsongrass	20
Johnsongrass	20	—	Kochia	30
Kochia	—	5	Lambsquarters	0
Lambsquarters	0	60	Morningglory	0
Morningglory	0	0	Nightshade	0
Nightshade	0	95	Nutsedge, Yellow	0
Nutsedge, Yellow	0	0	*Panicum*, Fall	0
Panicum, Fall	0	25	Pigweed, Palmer	0
Pigweed, Palmer	25	—	*Poinsettia*, Wild	0
Poinsettia, Wild	0	0	Ragweed	0
Ragweed	0	0	Ryegrass, Italian	0
Ryegrass, Italian	0	0	Sandbur	0
Sandbur	0	5	Smartweed	0
Smartweed	0	—	Soybean	0
Soybean	0	0	Surinam Grass	0
Surinam Grass	0	0	Velvetleaf	0
Velvetleaf	0	0	Waterhemp	50
Waterhemp	85	50		

Test G

Seeds of smallflower umbrella sedge (CYPDI, *Cyperus difformis*) and ducksalad (HETLI, *Heteranthera limosa*) were sown on the soil surface in two separate quadrants of 11 cm tubs filled with steam pasteurized Tama soil. Simultaneously, plantings of barnyardgrass (ECHCG, *Echinochloa crus-galli*) and *japonica* rice (ORYSP, *Oryza sativa*) were established in separate "plug" flats. Plants were grown in a greenhouse using supplemental lighting to maintain a photoperiod of approximately 16 h; daytime and nighttime temperatures were approximately 27-30° C. and 19-22° C., respectively. After 8 days, barnyardgrass plants were transplanted to one of the remaining quadrants of the tub, and the water level was adjusted to a final depth of 3 cm. Herbicide application timing was targeted at the 2.0 to 2.5 leaf stage and the plants were treated with test chemicals formulated in a non-phytotoxic solvent. Treated plants and controls were maintained in a greenhouse for 14 days, after which time all species were compared to controls and visually evaluated. Plant response ratings are summarized in Tables G1 through G3, and are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE G1

Results from Compd. No. 16 Alone and in Combination with Bensulfuron-Methyl (b2a)

Treatment	Rate (g/ha)	ORYSP	ECHCG	CYPDI	HETLI
b2a	16	0	60	90	90
b2a	31	0	68	90	95
b2a	62	0	75	93	98

TABLE G1-continued

Results from Compd. No. 16 Alone and in Combination with Bensulfuron-Methyl (b2a)

Treatment	Rate (g/ha)	ORYSP	ECHCG	CYPDI	HETLI
Compd. No. 16	8	10	25	85	0
Compd. No. 16	16	15	35	85	60
b2a + Compd. No. 16	16 + 8	0	40	93	99
b2a + Compd. No. 16	31 + 8	8	58	97	100
b2a + Compd. No. 16	62 + 8	13	73	98	100
b2a + Compd. No. 16	16 + 16	18	45	95	99
b2a + Compd. No. 16	31 + 16	25	52	96	98
b2a + Compd. No. 16	62 + 16	18	67	98	99

TABLE G2

Results from Compd. No. 129 Alone and in Combination with Bensulfuron-Methyl (b2a)

Treatment	Rate (g/ha)	ORYSP	ECHCG	CYPDI	HETLI
b2a	32	0	60	90	90
b2a	64	0	68	90	95
b2a	125	0	75	93	98
Compd. No. 129	16	0	0	0	0

TABLE G2-continued

Results from Compd. No. 129 Alone and in Combination with Bensulfuron-Methyl (b2a)

Treatment	Rate (g/ha)	ORYSP	ECHCG	CYPDI	HETLI
Compd. No. 129	32	10	5	48	25
b2a + Compd. No. 129	32 + 16	0	47	99	99
b2a + Compd. No. 129	64 + 16	5	60	98	99
b2a + Compd. No. 129	125 + 16	13	72	99	100
b2a + Compd. No. 129	32 + 32	3	40	98	98
b2a + Compd. No. 129	64 + 32	10	55	93	95
b2a + Compd. No. 129	125 + 32	17	68	94	98

TABLE G3

Results from Compd. No. 129 Alone and in Combination with 5-[(2-hydroxy-6-oxo-1-cyclohexen-1-yl)carbonyl]-2-(3-methoxyphenyl)-3-(3-methoxypropyl)-4(3H)-pyrimidinone (b12a)

Treatment	Rate (g/ha)	ORYSP	ECHCG	CYPDI	HETLI
Compd. No. 129	31	5	15	75	40
b12a	125	5	35	80	80
Cmpd. No. 129 + b12a	31 + 125	13	93	95	100

Test H

Seeds of plant species selected from wheat (TRZAW, *Triticum aestivum*), barley (HORBW, *Hordeum vulgare*), *Kochia* (KCHSC, *Kochia caoparia*) blackgrass (ALOMY, *Alopecurus myosuroides*), canarygrass (PHAMI, *Phalaris minor*), Italian ryegrass (LOLMU, *Lolium multiflorum*) common lambsquarter (CHEAL, *Chenopodium album*), pigweed (AMARE, *Amaranthus retroflexus*), Common Chickweed (STEME, *Stellaria media*), Russian thistle (SASKR, *Salsola iberica*), Wild Buckwheat (POLCO, *Polygonum convolvulus*), Catchweed Bedstraw (GALAP, *Galium aparine*), Mustard (SINAR, *Sinapisar arvensis*), Henbit Deadnettle (LAMAM, *Lamium amplexicaule*), Wild Radish (RAPRA, *Raphanus raphanistrum*), Field Poppy (PAPRH, *Papaver rhoeas*), Field Violet (VIOAR, *Viola arvennsis*), Scentless Chamomile (MATIN *Matricaria inodora*) were planted into soil and treated post-emergence with test chemicals formulated in a non-phytotoxic solvent mixture. Plants were grown in a greenhouse using supplemental lighting to maintain a photoperiod of approximately 14 hours; daytime and nighttime temperatures were approximately 23°-29° and 16°-19° Celsius, respectively. Balanced fertilizer was applied through the watering system. Treated plants and controls were maintained in a greenhouse for 20 days, after which time all species were compared to controls and visually evaluated. Plant response ratings were calculated as the mean of three replicates (unless otherwise indicated), are summarized in Table G, and are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (-) response means no test result.

TABLE H1

Results from Compd. No. 129 Alone and in Combination with Flupyrsulfuron-methyl (b2b) and in Combination with Thifensulfuron-methyl (b2c)

Treatment	Rate	TRZAW	HORBW	KCHSC	SASKR	STEME	CHEAL
Compd. No. 129	31	10	10	80	65	50	85
Compd. No. 129	62	15	15	85	80	70	80
Compd. No. 129	125	15	15	95	90	80	90
b2b	8	0	20	75	50	90	60
b2b	16	5	30	100	50	100	85
b2b	31	5	60	80	50	100	75
b2b	62	25	70	95	60	100	80
b2c	8	0	0	70	100	85	85
b2c	16	0	5	85	100	100	70
b2c	31	0	5	95	100	100	100
b2c	62	5	5	100	100	100	95
Compd. No. 129 + b2b	31 + 8	10	35	90	50	95	80
Compd. No. 129 + b2b	31 + 16	10	35	95	50	100	85
Compd. No. 129 + b2b	31 + 31	15	70	90	95	100	95
Compd. No. 129 + b2b	31 + 62	25	75	95	60	100	95
Compd. No. 129 + b2b	62 + 8	15	35	90	65	100	90
Compd. No. 129 + b2b	62 + 16	20	40	100	100	100	95
Compd. No. 129 + b2b	62 + 31	20	60	100	70	100	95
Compd. No. 129 + b2b	62 + 62	25	75	100	65	100	100
Compd. No. 129 + b2b	125 + 8	15	35	90	90	100	95
Compd. No. 129 + b2b	125 + 16	15	65	90	90	100	75
Compd. No. 129 + b2b	125 + 31	25	75	95	90	95	95
Compd. No. 129 + b2b	125 + 62	40	80	100	95	100	—
Compd. No. 129 + b2c	31 + 16	10	10	100	95	95	80
Compd. No. 129 + b2c	31 + 31	10	10	90	100	95	95
Compd. No. 129 + b2c	62 + 16	10	10	85	100	90	95
Compd. No. 129 + b2c	62 + 31	10	10	95	100	100	95
Compd. No. 129 + b2c	62 + 62	10	10	95	95	95	95
Compd. No. 129 + b2c	125 + 16	15	20	100	100	100	100

TABLE H1-continued

Results from Compd. No. 129 Alone and in Combination with Flupyrsulfuron-methyl (b2b) and in Combination with Thifensulfuron-methyl (b2c)

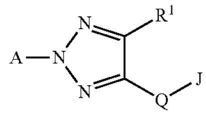
Compd. No. 129 + b2c	125 + 31	15	20	100	95	100	95
Compd. No. 129 + b2c	125 + 62	15	20	100	95	100	—

Treatment	Rate	POLCO	AMARI	SINAR	GALAP	LAMAM	RAPRA
Compd. No. 129	31	30	80	80	65	60	60
Compd. No. 129	62	25	90	95	60	70	85
Compd. No. 129	125	70	95	95	70	80	90
b2b	8	100	100	100	90	90	100
b2b	16	85	100	95	95	95	100
b2b	31	100	100	100	90	95	100
b2b	62	100	100	100	100	90	100
b2c	8	95	100	80	80	60	95
b2c	16	95	100	90	90	70	75
b2c	31	95	100	85	75	75	100
b2c	62	95	100	95	95	75	95
Compd. No. 129 + b2b	31 + 8	100	100	95	95	95	100
Compd. No. 129 + b2b	31 + 16	90	100	100	95	95	100
Compd. No. 129 + b2b	31 + 31	100	100	100	100	95	100
Compd. No. 129 + b2b	31 + 62	100	100	100	100	90	100
Compd. No. 129 + b2b	62 + 8	95	100	100	95	85	100
Compd. No. 129 + b2b	62 + 16	100	100	100	100	90	100
Compd. No. 129 + b2b	62 + 31	95	100	100	100	90	100
Compd. No. 129 + b2b	62 + 62	100	100	100	100	100	95
Compd. No. 129 + b2b	125 + 8	95	100	100	100	85	100
Compd. No. 129 + b2b	125 + 16	95	100	95	95	90	100
Compd. No. 129 + b2b	125 + 31	95	100	100	100	90	100
Compd. No. 129 + b2b	125 + 62	100	100	95	95	90	100
Compd. No. 129 + b2c	31 + 16	90	100	85	65	70	95
Compd. No. 129 + b2c	31 + 31	95	100	90	80	70	95
Compd. No. 129 + b2c	62 + 16	95	100	85	85	70	100
Compd. No. 129 + b2c	62 + 31	100	100	90	85	90	100
Compd. No. 129 + b2c	62 + 62	100	100	95	95	90	100
Compd. No. 129 + b2c	125 + 16	95	100	95	80	85	95
Compd. No. 129 + b2c	125 + 31	95	100	90	95	85	95
Compd. No. 129 + b2c	125 + 62	100	100	95	100	85	95

Treatment	Rate	PAPRH	VIOAR	MATIN	LOLMU	PHAMI	ALOMY
Compd. No. 129	31	85	60	0	10	15	5
Compd. No. 129	62	90	75	5	10	20	10
Compd. No. 129	125	90	90	10	15	60	30
b2b	8	100	50	90	60	40	100
b2b	16	90	75	95	60	55	100
b2b	31	100	70	100	65	85	100
b2b	62	95	95	95	80	90	100
b2c	8	70	80	95	20	10	10
b2c	16	75	85	90	50	60	45
b2c	31	100	75	100	70	70	60
b2c	62	100	95	100	90	90	65
Compd. No. 129 + b2b	31 + 8	90	60	100	65	55	95
Compd. No. 129 + b2b	31 + 16	90	65	100	70	65	95
Compd. No. 129 + b2b	31 + 31	100	80	100	75	70	100
Compd. No. 129 + b2b	31 + 62	100	100	100	75	95	100
Compd. No. 129 + b2b	62 + 8	85	95	95	50	25	95
Compd. No. 129 + b2b	62 + 16	90	70	95	60	55	95
Compd. No. 129 + b2b	62 + 31	90	85	95	65	70	100
Compd. No. 129 + b2b	62 + 62	95	85	95	85	95	95
Compd. No. 129 + b2b	125 + 8	75	65	90	60	55	90
Compd. No. 129 + b2b	125 + 16	85	70	95	70	60	95
Compd. No. 129 + b2b	125 + 31	100	80	90	60	70	95
Compd. No. 129 + b2b	125 + 62	90	85	95	90	85	95
Compd. No. 129 + b2c	31 + 16	70	75	80	10	25	15
Compd. No. 129 + b2c	31 + 31	75	75	90	20	35	45
Compd. No. 129 + b2c	62 + 16	80	90	90	20	60	40
Compd. No. 129 + b2c	62 + 31	80	75	95	65	75	50
Compd. No. 129 + b2c	62 + 62	95	80	95	65	90	60
Compd. No. 129 + b2c	125 + 16	95	80	95	60	60	60
Compd. No. 129 + b2c	125 + 31	95	80	100	60	75	65
Compd. No. 129 + b2c	125 + 62	95	80	95	70	85	70

What is claimed is:

1. A compound selected from Formula 1, N-oxides and salts thereof,



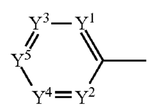
1

wherein

R^1 is halogen, cyano, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy, C_2-C_6 alkylcarbonyloxy, C_1-C_4 hydroxyalkyl, $SO_n(R^{12})$, C_2-C_4 alkylthioalkyl, C_2-C_4 alkylsulfonylalkyl, C_1-C_4 alkylamino, C_2-C_4 dialkylamino, C_3-C_6 cycloalkyl or hydroxy;

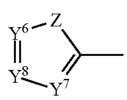
A is a radical selected from the group consisting of

A-1



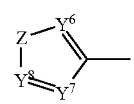
,

A-2



and

A-3



each Y^1, Y^2, Y^3, Y^4 and Y^5 is independently N or CR^2, provided no more than 3 of Y^1, Y^2, Y^3, Y^4 and Y^5 are N;

each Y^6, Y^7 and Y^8 is independently N or CR^3, provided no more than 2 of Y^6, Y^7 and Y^8 are N;

Z is O or S;

Q is $C(R^4)(R^5)$, O, S or NR^6;

J is phenyl substituted with 1 R^7 and optionally substituted with up to 2 R^8; or

J is a 6-membered aromatic heterocyclic ring substituted with 1 R^7 and optionally substituted with up to 2 R^8 on carbon ring members; or

J is a 5-membered aromatic heterocyclic ring substituted with 1 R^9 on carbon ring members and R^{11} on nitrogen ring members; and optionally substituted with 1 R^{10} on carbon ring members;

each R^2 is independently H, halogen, cyano, nitro, SF_5, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy or $S(O)_nR^{12}$;

each R^3 is independently H, halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^2$;

R^4 is H, F, Cl, Br, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl or CO_2R^{13};

R^5 is H, F, C_1-C_4 alkyl, OH or OR^{13}; or

R^4 and R^5 are taken together with the carbon to which they are attached to form C(=O), C(=NOR^{13}) or C(=N—$N(R^{14})(R^{15})$);

R^6 is H, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^7 is halogen, cyano, SF_5, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$;

each R^8 is independently halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$; or

R^7 and R^8 are taken together with two adjacent carbon atoms to form a 5-membered carbocyclic ring containing ring members selected from up to two O atoms and up to two S atoms, and optionally substituted on carbon atom ring members with up to five halogen atoms;

R^9 is halogen, cyano, SF_5, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$;

R^{10} is halogen, cyano, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or $S(O)_nR^{12}$;

R^{11} is C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^{12} is independently C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^{13} is independently H or C_1-C_4 alkyl;

R^{14} is C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^{15} is C_1-C_4 alkyl or C_1-C_4 haloalkyl; and

each n is independently 0, 1 or 2;

provided

i) when R^1 is CH_3; A is A-1; Y^1, Y^2, Y^3 and Y^4 are each CH; and Y^5 is CCF_3 then J is other than 3-chloro-1H-1,2,4-thiadiazol-5-$Y^{1,4}$-fluoro-2-pyridinyl, 4-chlorophenyl or 2,4-dichlorophenyl; and

ii) when R^1 is CH_3; A is A-1; Y^1, Y^2, Y^3 and Y^4 are each CH; and Y^5 is CF then J is other than 4-fluoro-3-methylphenyl.

2. The compound of claim **1** wherein

R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_2-C_4 alkenyl, C_2-C_4 alkynyl, C_3-C_4 alkenyloxy, C_3-C_4 alkynyloxy, C_2-C_6 alkylcarbonyloxy, C_1-C_4 hydroxyalkyl, $SO_n(R^{12})$, C_2-C_4 alkylthioalkyl or C_2-C_4 alkylsulfonylalkyl;

A is a radical selected from the group consisting of A-1 and A-2;

each Y^1, Y^3, Y^4 and Y^5 is independently N or CR^2; and Y^2 is CR^2;

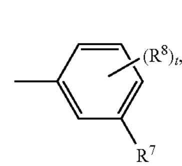
each Y^6 and Y^7 is independently N or CR^3; and Y^8 is CR^3;

Z is S;

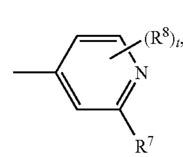
Q is $C(R^4)(R^5)$, O or S;

J is selected from the group consisting of

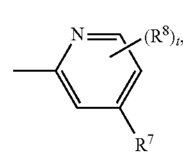
J-1



J-2



J-3



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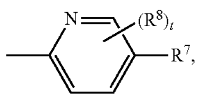

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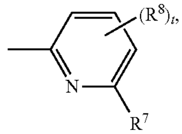
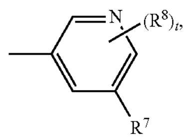
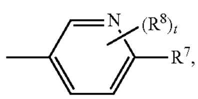


J-6



J-7



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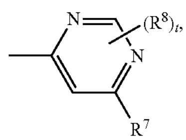

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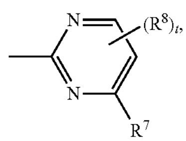

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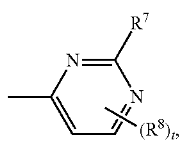
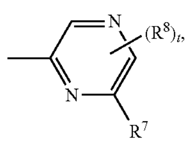
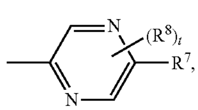


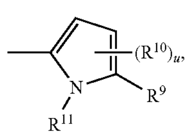
J-13



J-14



J-15



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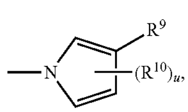

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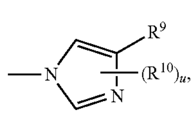

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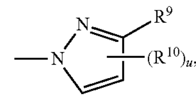
J-18



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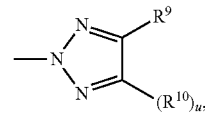
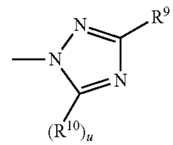
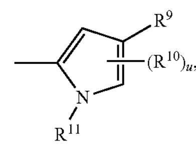


J-20



J-21



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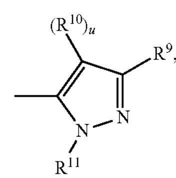
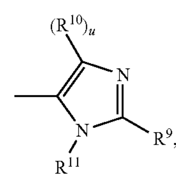
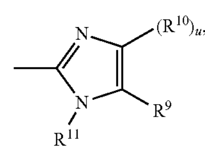


J-23



J-24



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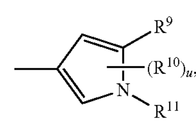
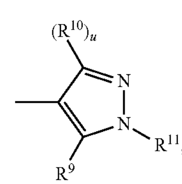


J-26



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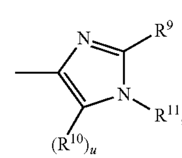

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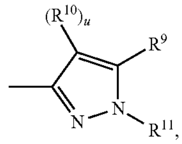
J-28



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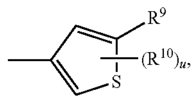

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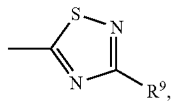
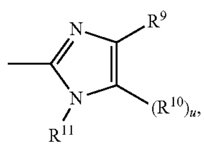


J-31



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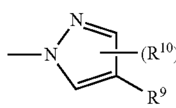
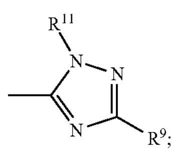


and

J-33



t is 0, 1 or 2;

u is 0 or 1;

each R^2 is independently H, halogen, C_1-C_4 alkoxy, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^3 is independently H, halogen or C_1-C_4 haloalkyl;

R^4 is H, F, Cl, Br or C_1-C_4 alkyl;

R^5 is H, F or OH; or

R^4 and R^5 are taken together with the carbon to which they are attached to form C(═O);

R^7 is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy;

R^8 is independently halogen or C_1-C_4 haloalkyl; or

R^7 and R^8 are taken together with two adjacent carbon atoms to form a 2,2-difluorodioxolane ring;

R^9 is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy;

R^{10} is halogen, C_1-C_4 alkyl, C_1-C_4 haloalkyl, C_1-C_4 alkoxy or C_1-C_4 haloalkoxy;

R^{11} is C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^{12} is independently C_1-C_4 alkyl;

each R^{13} is independently CH_3 or CH_2CH_3;

R^{14} is C_1-C_4 alkyl;

R^{15} is C_1-C_4 alkyl; and

n is 0 or 2.

3. The compound of claim **2** wherein

R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl, C_1-C_4 haloalkyl or C_2-C_4 alkenyl;

each Y^1 and Y^5 is independently N or CR^2; and each Y^2, Y^3 and Y^4 is CR^2;

each Y^6 and Y^7 is N; and Y^8 is CR^3;

Q is $C(R^4)(R^5)$ or O;

J is selected from J-1, J-2, J-3, J-4, J-5, J-6, J-7, J-9, J-12, J-17, J-18, J-20, J-22, J-26, J-29 and J-30;

t is 0 or 1;

u is 0;

each R^2 is independently H, halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

each R^3 is independently H, F, Cl or CF_3;

R^4 is H, F or CH_3;

R^5 is H or F;

R^7 is F, CH_3 or CF_3;

R^8 is independently F, Cl or CF_3;

R^9 is halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^{10} is halogen, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

R^{11} is C_1-C_4 alkyl;

each R^{12} is CH_3; and

each R^{13} is CH_3.

4. The compound of claim **2** wherein

R^1 is halogen, C_1-C_4 alkoxy, C_1-C_4 haloalkoxy, C_2-C_4 alkoxyalkyl, C_1-C_4 alkyl or C_1-C_4 haloalkyl;

A is A-1;

Y^1 is N or CR^2; and each Y^2, Y^3, Y^4 and Y^5 is independently CR^2;

Q is $C(R^4)(R^5)$;

J is selected from J-1, J-2, J-10, J-17, J-18 and J-20;

t is 0;

each R^2 is independently H, F, Cl, CH_3 or CF_3;

R^4 is H;

R^5 is H; and

R^7 is F or CF_3.

5. The compound of claim **3** wherein

R^1 is C_1-C_4 alkoxy, C_1-C_4 haloalkoxy or C_1-C_4 alkyl;

A is A-1;

Y^1 is N or CR^2; and each Y^2, Y^3, Y^4 and Y^5 is independently CR^2;

Q is O;

J is selected from J-1, J-2, J-17 and J-18;

each R^2 is independently H, F, Cl or CF_3; and

R^7 is CF_3.

6. The compound of claim **3** wherein

R^1 is CH_3;

each Y^1, Y^2, Y^3, Y^4 and Y^5 is independently CR^2;

J is J-2; and

each R^2 is independently H or F.

7. The compound of claim **1** selected from the group consisting of

4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]oxy]-2-(trifluoromethyl)pyridine and

4-[[5-Methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine.

8. The compound of claim **1** selected from the group consisting of

4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine;

4-[[2-(4-fluorophenyl)-5-methyl-2H-1,2,3-triazol-4-yl]oxy]-2-(trifluoromethyl)pyridine;

4-[[5-ethoxy-2-(4-fluorophenyl)-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine;

4-[[5-methoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine;

4-[[5-methyl-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine;

4-[[5-ethoxy-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl)pyridine; and

4-[[5-(2,2,2-trifluoroethoxy)-2-[4-(trifluoromethyl)phenyl]-2H-1,2,3-triazol-4-yl]methyl]-2-(trifluoromethyl) pyridine.

9. A herbicidal composition comprising a compound of claim **1** and at least one component selected from the group consisting of surfactants, solid diluents and liquid diluents.

10. A herbicidal composition comprising a compound of claim **1**, at least one additional active ingredient selected from the group consisting of other herbicides and herbicide safeners, and at least one component selected from the group consisting of surfactants, solid diluents and liquid diluents.

11. A herbicidal mixture comprising (a) a compound of Formula 1, N-oxides, and salts thereof from claim **1**, and (b) at least one additional active ingredient selected from (b1) photosystem II inhibitors, (b2) acetohydroxy acid synthase (AHAS) inhibitors, (b3) acetyl-CoA carboxylase (ACCase) inhibitors, (b4) auxin mimics, (b5) 5-enol-pyruvylshikimate-3-phosphate (EPSP) synthase inhibitors, (b6) photosystem I electron diverters, (b7) protoporphyrinogen oxidase (PPO) inhibitors, (b8) glutamine synthetase (GS) inhibitors, (b9) very long chain fatty acid (VLCFA) elongase inhibitors, (b10) auxin transport inhibitors, (b11) phytoene desaturase (PDS) inhibitors, (b12) 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitors, (b13) homogentisate solenesyltransererase (HST) inhibitors, (b14) cellulose biosynthesis inhibitors, (b15) other herbicides including mitotic disruptors, organic arsenicals, asulam, difenzoquat, bromobutide, flurenol, cinmethylin, cumyluron, dazomet, dymron, methyldymron, etobenzanid, fosamine, fosamine-ammonium, metam, oxaziclomefone, oleic acid, pelargonic acid and pyributicarb, and (b16) herbicide safeners;

and salts of compounds of

(b1) photosystem II inhibitors, (b2) acetohydroxy acid synthase (AHAS) inhibitors, (b3) acetyl-CoA carboxylase (ACCase) inhibitors, (b4) auxin mimics, (b5) 5-enol-pyruvylshikimate-3-phosphate (EPSP) synthase inhibitors, (b6) photosystem I electron diverters, (b7) protoporphyrinogen oxidase (PPO) inhibitors, (b8) glutamine synthetase (GS) inhibitors, (b9) very long chain fatty acid (VLCFA) elongase inhibitors, (b10) auxin transport inhibitors, (b11) phytoene desaturase (PDS) inhibitors, (b12) 4-hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitors, (b13) homogentisate solenesyltransererase (HST) inhibitors, (b14) cellulose biosynthesis inhibitors, (b15) other herbicides including mitotic disruptors, organic arsenicals, asulam, difenzoquat, bromobutide, flurenol, cinmethylin, cumyluron, dazomet, dymron, methyldymron, etobenzanid, fosamine, fosamine-ammonium, metam, oxaziclomefone, oleic acid, pelargonic acid and pyributicarb, and (b16) herbicide safeners.

12. A method for controlling the growth of undesired vegetation comprising contacting the vegetation or its environment with a herbicidally effective amount of a compound of claim **1**.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,302,999 B2
APPLICATION NO. : 14/437360
DATED : April 5, 2016
INVENTOR(S) : Matthew James Campbell et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In The Claims

Column 185, line 60; in Claim 1

"$S(O)_nR^2$"

should read

--$S(O)_nR^{12}$--

Column 186, line 27; in Claim 1

"thiadiazol-5-$Y^{1,4}$-fluoro-2-pyridinyl, 4-chlorophenyl or"

should read

--thiadiazol-5-yl, 4-fluoro-2-pyridinyl, 4-chlorophenyl or--

Signed and Sealed this
Eighth Day of November, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office